



*John Barlow*





## *To the Courteous Reader.*

**C**ourteous Reader, I haue written thee a small Discourse as concerning *Magneticall Bodies and Motions*, the which I hope will not be obscure vnto thee through his breuitie, because of his plaine method, and easie demonstrations, which with their pleasantnesse will proue very ready and apparant vnto thee, especially being animated from the *Magnet* stone it selfe, as from a most liuely and perfect teacher: Therefore I would aduise thee, that when thou readest this booke, that thou wouldest prouide thy selfe of such like formes of *Magnets* as I haue described in the first Table and figures of the second chapter, as also of needles, wiers, and waights of iron and steele, set forth in the second Table of the third chapter of this booke, which thou mayest haue made and prouided for thee by the helpe of some skilfull workemen: when thou shalt be furnished with these kinds of prouisions, then thou mayest reade and practise the operations and demonstrations of this booke, which will be both easie and very pleasant vnto thee; and though that there be many precepts and practises in this Booke, which be not for example sake set downe in tables and figures vnto thy sight, because I desired

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to be very briefe, yet if thou shalt not be altogether vnskillfull in these demonstrations that be delineated in the Tables of this booke and their often practise, thou wilt be able inough to vnderstand and put them in vre, with these forenamed prouisions. But if thou shalt desire, besides thy instruction in this kind of learning, to put in vse and make benefit of these matters *Magneticall*, either in traouelling or sailing vpon the *Magneticall* globe of the earth, then it will be very necessary for thee to be stored with the Marriners Compasse for the sea, perfectly drawne and framed, to know the way, and of what hand and point to saile and trauell, and also to haue the *Inclinatory-needle* truly placed in his ring, and a *Directory-needle*, or a little flie *Magneticall* in the boxe, fastened at the bottome in his conuenient distance, for to know vnder what latitude thou art euery day of thy voyage: Likewise if I should declare vnto thee how beneficiall the *Directory-Magneticall-needle* is for the description of Ports, Hauens, Forlands, Capes, Bayes and Riuers, for the more perfect making of Sea-cards, how necessary for the positure of buildings, directing of dials, and all Mathematicall instruments for measuring and surueying, for pioners and vnderminers of forts, for searchers of minerals, mettals, sea-coles, and other subterrestriall bodies, I should be too tedious vnto thee, and will rather referre thee for these matters to that which is set downe by others, because I meddle here in this booke onely with those things that be *Magneticall*.

In this place I thinke good to aduertise thee as concerning the magnitude of the seuen Planets, with their respect vnto the earth, out of *Ticho Brahe*, described in the top of the Title Page; that whereas their proportion

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tion cannot be set forth truly in any types, being at too great oddes: therefore I haue deciphered that in figures; as let the *Earth*  $\square$  be but one part, the *Sunnes*  $\circ$  greatnesse will be 140 times so much; *Saturnes*  $\star$  22, *Iupiters*  $\star$  14. And if that *Venus*  $\star$  haue 6 parts, the *Earth* will haue 37 parts, if *Mars*  $\star$  be one part, the *Earth* is 13, if *Mercury*  $\star$  be one part, the *Earth* is 18, if the *Moone*  $\circ$  be one part, the *Earth* will continue her 42 times. Besides, I haue drawne the *Axis* in the greater Planets, as being bodies *Magneticall*: for I trust that these following times will discover whether they be paralell one to the other, or no, as also what naturall motions else they haue, because that *Astra natant, anis instar in aëre, aut piscis in vnda*, and here it might be sayd that we hope that many new points in Philosophy and Astronomy will blossome and spring out of this kind of learning hereafter,

*Thine in all affection,*

M. R.

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## A Preface Magneticall.

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*P*urposing to deliuer a brieft and easie doctrine as concerning this new Art of Magneticall Bodies and Motions: I thought good here to free the same from the lustre and glosse of disputable points and other conceits, onely purposing to handle nothing in the same but the plaine matter and demonstrations Magneticall themselves, thinking it more fitting to place these flowers in the Preface, if any delight rather in them, then in the matter it selfe, to the end they may in some sort be provided of both. As concerning the first finding out of the Magnet-stone, whereof I am to treat, Plinie and Nicander haue fained that a certaine Herdman being in the fields, hauing his shoes shod with iron, and his staffe armed with an iron pike, and resting himselfe vpon a quantity of this stone, could not easily remoue his feete, or lift vp his staffe, whereupon he perceiued the attractiue vertue of this stone, that it did attract and hold iron. Other thinke that the pioners and diggers of metals, by their diligence and obseruances first found out the Load-stone, and his vertue of attracting iron, by which property it was well knowne to the antient Egyptians and Græcians in times past. Some haue thought that the

a

Magnet

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Magnet would leese this quality attractive, if he were annointed with garlicke, or touched with a Diamond, and of this opinion were Ptolomie, Plutarcke, Plinie, and Baptista Porta; for this mallady Ruelius hath found a remedy to annoint the Load-stone with Goates bloud, and Paracelsus with his oyle of Crocus Martis, will not onely cure him of this euill, but can make him ten times stronger then he was before, likewise Cardanus and Alexander Amphrodiseus haue laboured to nourish the Magnet with filings of iron and Steele.

Many haue strined much to inquire out the cause how the Magnet should attract iron vnto it, Epicurus, Aphrodiseus, Carus, Iohannes Costæus, Plutarke, and Thomas Aquinas do suppose this attractive vertue to proceed from certaine mores, vsensible parts or vapors issuing forth of the Magnet, and entring into the iron by conuenient figures, and in their retiring backe againe do attract the iron to the Load-stone.

Plato and Fernelius haue thought the cause of this attraction to be Diuine and from aboue. Thales and Anaxagoras say that the Magnet hath life in it, whereby it attracteth the like substance as liuing things do. Some thinke that there is a certaine sympathie betweene the Magnet and iron, as betweene the male and female, as Orpheus and Lucretius haue sung.

Auaroës, Scaliger, and Cardinall Cusanus would haue iron to moue vnto the Magnet, as to his beginning and matrixe from whence he came. Gulielmus Puteanus, Galen, and others, do iudge that by his substantiall forme he draweth iron vnto it, but Doctör Gilbert, whose labours are the greatest, and best in Magneticall Philosophie, doth conceiue that the Magnet and iron do moue one vnto the other, not by any specificall forme, but from the essentiall

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*essentiall forme of the Magneticall globe of the earth, being an essentiall part of the same, which is not so, as it shall be demonstrated in the last Chapter of this Treatise.*

*To illustrate this vertue of attraction in the Load-stone, Serapio and the Moores, like farre travellers, haue reported that in the Indies there be mighty craggie rockes, all of Magnet-stone, that will stay the ships as they saile by them, and pull the iron nailes out of them; this story Olaus Magnus also confirmeth to be so in the North, and that there, least the rockes of Load-stone should pull the iron workes and nailes from the vessels and boates, they build them with wodden pins, and sowe the boords together with lines of the barkes of trees; which indeed they do both for want of our skill in building ships and barges, and for want of iron-workes, whereof they haue little store.*

*And because this stone hath vertue to attract, therefore Marbodeus a French-man, Petrus Bairus, Pictorius and Arnoldus de villa noua do faine that this stone will procure the loue of Princes and of women, and maintaine loue betweene husband and wife. Haly-abbas will haue the Load-stone to cure the goute, if it be held in the hand, and the East Indians say that it preserueth youth. Cælius Calcaginus saith, that if the Magnet be preserued in the salt of the sea-Lampron or Remora, that is thought to stay a ship vnder saile, that then the Magnet will draw vp gold that is fallen into the deepest well.*

*And Fracastorius testifieth that he hath seene a Magnet that would draw siluer vnto it, and chase iron from it. Cardanus, Antonius de Fantis, Petrus Perigrinus, and Iohn Taisner do deliuer that there might be made a perpetuall motion by the vertue of the Load-stone, but by the experience of many ingenious practises I find it un-*



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possible to be done.

Since the finding out of the Sea-compassse, which was about 300 yeares ago, by one Thomas Goa, borne neere Naples, or by Marcus Paulus Venetus, who learned that skill in China, as is thought, and first brought it into Italy, there haue growne many opinions how this Compassse should be directed into the North and South. Marcilius Ficinus, Paracelsus, and Cardan thinke that the vertue of the constellation of the Beare doth gouerne the Magnet and iron, and therefore both these are directed into the North. Petrus Peregrinus, Frier Bacon, Iohn Taifner, and many other would haue the Compassse to obserue the North pole: But since that Sebastianus Cabotta, did find out that the Compassse did vary from the true meridian, it hath bene imagined that there is some place in the heauens that the Compassse should respect, as Cardan would haue it, to obserue the starre in the taile of Vrsa major. Bessardus, a Frenchman saith that it doth behold the pole of the Zodiacke, Martin Cortesius would haue an attractive point aboue the heauens, and Robert Norman an Englishman, denieth that there is an attractive point, but affirmeth that there is a respectiue point, to the which the Compassse doth moue, especially the Inclinary-needle, whereof he was the first inuentor.

Liuius Sanulus supposeth that there is a certaine Magneticall meridian, and Francis Maurolicus, that there is a Magneticall Iland, and Fracastorius holdeth that there be certaine Magneticall mountaines, which be set out in Plancius his Card, that the Compassse doth respect. But Doct<sup>r</sup> Gilbert, our friend and Collegiat, hath discovered these errors, and set forth the causes of the variation of the Compassse in his booke De Magnete.

Yet lately Gulielmus Nauionerius, a Frenchman, and  
Anthony



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Anthony Linton an Englishman haue supposed that the Magneticall-needle and Compasse do moue and turne themselves vpon the Magneticall meridian alwayes vnto their owne Magneticall poles, placed vpon the superficies of the earth that be neere, and within the circles polar, not varying at all from their owne meridian, but deuiate on-ly and decline from the meridians of the pole of the world, and with this conceit, these two, with many curious calculations and proiects, will presently find the longitude of all Cities and Countries; but this their strong imagination hath failed them, being grounded vpon obseruations from the variations of the needle, from which these two men haue set forth different Magneticall poles; and if they should worke from 500 obseruations, they might gesse at neere halfe as many varietie of poles (for variations are not regular, but irregular, because their scattered causes be irregular) so that these men haue found instead of the longitude of places, a longitude of vnprofitable labors.

Therefore, not purposing to dazell any ones conceit with the repetition and confutation of any opinions, termes of Art, or words whatsoeuer, I will come to the Tractate it selfe, thinking that the quivering Magneti-call-needle will be trouble inough to handle for the better knowledge and delight in Magneticall Experiments.

M. R.



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*contained in this Treatise.*

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Misus ab Elisa Ruthenis quinque per annos  
 Anglis ni desis te Vocat illa domum  
 Tule mathematicis clarus magnetica calles  
 Paonias laudes doctus Ubi que capis.





# A SHORT TREATISE OF MAGNETICALL BODIES AND Motions.

## CHAPTER I.

### *Of Bodies Magneticall.*

**T**HAT we define to be a *Magneticall body*, which seated in the *ether* or *aire*, doth remaine and place it selfe in one place or kind of situation naturall, not alterable; as all starres do, and the great regent Globes of *Saturne*, *Mars*, *Iupiter*, the *Sunne* and the *Earth* do; or such as with respect and attendance follow other Globes, as the two starres which support *Saturne*, the foure attenders vpon *Iupiter*, lately discovered by the trunke spectacle, the two trauesers about the *Sunne*, called *Venus* and *Mercury*, and lastly the *Moone*, which doth follow, or go about the *Earth*, and respecteth the same

B

alwayes

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alwayes with one pole : and therefore hath a peculiar *Magneticall* vertue that guideth her in this kinde of situation.

All *Magneticall Globes* haue some parts of their bodies which be also *Magneticall*, which being seperated from their proper globes, and no way hindered, will seate themselues or be seated vnto the naturall situation of their particular Globes.

The *Earth*, whereon we liue and moue, hath two minerals that be *Magneticall*, the one is the *Magnet* or *Load stone*, which draweth iron vnto it, and this iron or Steele is the other. Either of these two being conueniently, and artificially placed in the aire, or in a boate on the water, freed from all obstacle and renitency, will place and rest certaine parts of themselues, which be called the poles of their body, respondent vnto the poles of the Earth, which situation we call North and South, because they be parts of the *Magneticall* globe of the Earth, who by her attractiue and disponent vertue, doth thus direct and situate them.

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### CHAP. II

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#### *Of the Magnet stone, his forme and caps.*



He *Magnet* stone is heauie and massie, like vnto iron, hauing much Steele and iron in it, this stone will attract, hold, disperse, and compone like a little earth other lesse *Magnets* and *Magneticall* formes of iron and Steele to his conformitie of *axis* and poles. This stone is called the *Magnet*,

*Magnet*, of a countrey in *MACEDONIA* so termed, where plenty of them are found, it is called *Hercules stone*, of a City of that name, and it is called the Iron stone of drawing it, we call it the *Load-stone*, the *Adamant stone*, and the *Osmound stone* in our Iron-mongers shops; because of his leading directiue and attractiue qualitie, and it is well termed the *Osmound stone*, because he is as it were *Os mundi*, the bone of the world: for by his vertue *Magneticall* he is like a bone and pillar whereby this world and globe of the Earth is sustained and supported in his iust situation, as the litle world of the body of man is supported by his bones.

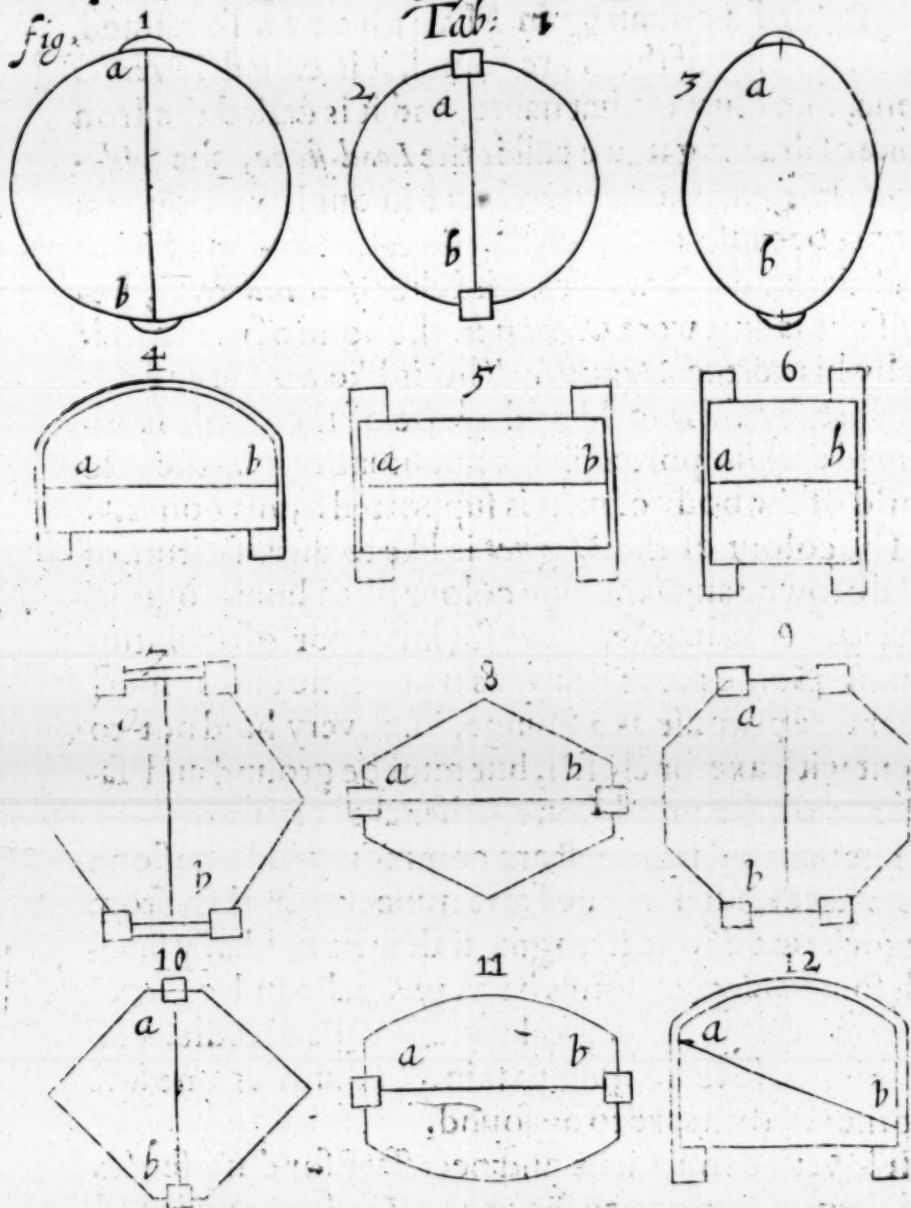
The colour of the *Magnet* is like to duskyish iron, of a sad browne and sanguine colour like a liuer, some of them are cole-blacke, blewish, ashey, or of a whitish colour. Some are as heauy as iron, firme and sollide, other rare porouse as a sponge, some very hard not to be cut with axe or chisell, but must be ground and fashioned on the grind-stone, other are very soft.

The best and strongest are commonly found of one intire peece, such as be of one mine and broken from the rocke are of one strength, if they be suddenly seuered; some *Magnet* stones be very weake and of little force to take vp, only good to moue the Needle. The stone is not so scarce, but that in all countries one sort or other of them are to be found.

It is very conuenient and necessary for diuerse vses and demonstrations to haue the *Load stones* ground and formed by the grind-stone: or otherwile sawen with sand and emery into diuerse formes, fashions, and figures, and after by the Cutter of precious stones to be finely polished: and also artificially capped and armed with Steele, or iron, by the hand of some inge-

fig.

Tab: 1



nious Smith.

The first forme of the *Magnet*, which I offer vnto your eyes, *Table I. Fig. 1.* is a large one, in fashion of a round ball, boule or globe, and we do call it a *Terrella*, or



or little earth, because that vpon this figure of the body of the *Magnet stone*, we shall hereafter shew how to find naturally the poles and the rest of the circles of the Spheare, prouing vnto your eyes all kinds of *Magneticall* demonstrations on it, and shall after, most fitly and naturally, declare how to obserue them in traouelling or sailing vpon the great *Magneticall* globe of the earth. This forme may be artificially capped and armed with Steele, or iron, at his two poles, *Tab. I. Fig. 1. a b*, for to take vp iron waights, or to touch *Magneticall* needles withall.

The next fashion is a round and flat forme, of a reasonable thickeesse like a coire, cake, halfe boule, Holland-cheese, or part of a columnne, *Table I. Fig. 2.* and may be called a *Semiterrella* his poles, *Tab. I. Fig. 2. a b* must be situated in the middest of the sides of the roundle. This forme may be capped artificially at either pole, *Tab. I. Fig. 2. a b* with two square teeth of iron, *Tab. I. Fig. 2. a b*, descending at right angles to the line of the *axis*, *Tab. I. Fig. 2. a b*, and this is almost as conuenient as the former in the first figure of this first Table for all *Magneticall* demonstrations, which are performed onely vpon a Meridian circle that passeth by the two poles, which this forme hath. And the stone for this forme is more readily procured then that is of the first and globous fashion.

The Oual and long forme like an egge, *Tab. I. Fig. 3.* is thought to be the best fashion, by some, for to touch the needles of the sea Compas withall, and to take vp waights at one end, *Tab. I. Fig. 3. a b*, because he hath a long diameter line, *Tab. I. Fig. 3. a b*.



The long egge forme flatted at the bottome with two iron teeth from the two poles, *Tab. I. Fig. 4. a b*, as

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the *Semiterrella* hath, *Tab. I. Fig. 2. a b*, the square formes with foure teeth from the two poles, *Tab. I. Fig. 5. & 6. a b*, two teeth at one end, all these are very fit fashions to take vp great waights, and to touch *Magneticall* bodies and instruments withall, as shall be hereafter set foorth.

There be many other fashions that may be inuented and wrought at pleasure of the Cutter, or as the *Load-stone* will be fittest for, as the sixth square, *Tab. I. Fig. 7.* the fixe angles vnequall, *Tab. I. Fig. 8.* The foure angles, *Tab. I. Fig. 10.* and of many other fashions, as *Tab. I. Fig. 9. 11. 12.* which may be described, all which being flatted or rounded at their poles, *Tab. I. a b*, hauing their caps with one or two teeth, will take vp by them both, or seuerally, and are good to touch needles, wiers, knives, daggers, and such like long formes, to giue them vertue to take vp smaller wiers, sowing-needles and such like small waights, or to giue the vertue polar.

You may cap and arme some kinde of formes of *Magnets* with foure teeth, two teeth from the side flatted at either pole, as we haue described *Tab. I. Fig. 7.* which hath foure square iron teeth, like a foure footed stoole, to raise vp waights with foure teeth together.

If you had a *Magnet* stone of a flat forme, that had his poles in the center of the stone, as these I haue described haue their poles in the ends, then you might place one side with his pole downward, and the other side vpward, and prouide you a cap for the vppermost side, like a Greeke P , and a cap for the nethermost side like a Slaunonian T , and these being artificially and discussiue fastened to this *Loadstone*,  
would

would take vp waights with five teeth, as it were an hand with five fingers.

I haue drawne a line *ab* in all these formes, paralell to the *axis* of the *Loadstone*, to the end that the caps of iron, crossing the poles and *axis ab* at right angles, may be the better perceined.

Neuerthelesse, in fashioning of some *Load-stones*, the *axis* cannot so aptly be alwayes placed in the midst of the ends of the *Load-stones* being flatted, vnlesse there be a greater part of the *Load stone* taken away, & the bulke very much diminished, which will lessen much the strength of the stone: for the greater that the bulke is, the more is the strength of the *Magnet*.

Therefore I haue set downe a type in the last place, *Tab. I. Fig. 12.* where the diamiter *ab* lieth awry, and the poles be situated higher and lower at the ends, and yet the *Loadstone* shall take vp as much in waight as if his diamiter lay not obliquely.

The hilly knobs and angulous parts of the *Load-stone* may be sawen away with sand or emery, without any hurt to the vertue of the stone, and sometimes many ounces may be cut away without any losse of *Magneticall* vigor, especially if any substances of other nature be intermingled and agglutinated to the *Magnet*, which may be knowne by their colour and hardnesse very easily.

Also, if there be any cauities and hollow places, or broken parts of the *Loadstone* that do diminish his vertue, or disfigure his forme, this may be supplied, mended and filled, either with a peece of another *Loadstone*, or with a cement of the powder of the *Loadstone*, and the filings of steele or of iron brayed and grinded very finall vpon a painters stone, mixed with rozen and  
waxe,



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waxe, melted and coloured to the colour of the *Magnet* that is mended, putting into this cement more or lesse of the filings, according to the strength of the *Loadstone*. Some with this cement, and such like glutinous matter, make diuerse formes of *Magneticall* bodies artificiall.

It is very conuenient for makers of sea-compasses, and maisters of ships to haue a *Magnet* well capped, that taketh vp at one end halfe a pound waight at lest, for it is not wholly necessary that the same should be of the best vigour and strongest rocke: for all *Loadstones*, both of great and lesse vigour, haue the same facultie *Magneticall* to all intents and purposes. The greater stones of the same rocke haue a larger vertue then the lesse, and euery part and small peeces of *Magnet* stones haue euery one of them the same vertue and vigour *Magneticall* the great ones haue, sauing that they be more weake, and not alwayes proportionable in strength vnto them.

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### CHAP. III.

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#### *Of Iron.*



**I**Ron is a mettall decocted out of the *Loadstone*, or out of a mine of that kind. The best iron-mine and *Loadstone* is all one thing and body *Magneticall*, for it being placed artificially, either in the aire or vpon the water, moueth North and South, attracteth other iron vnto it, and performeth the same conclusions that the *Magnet*



net stone doth.

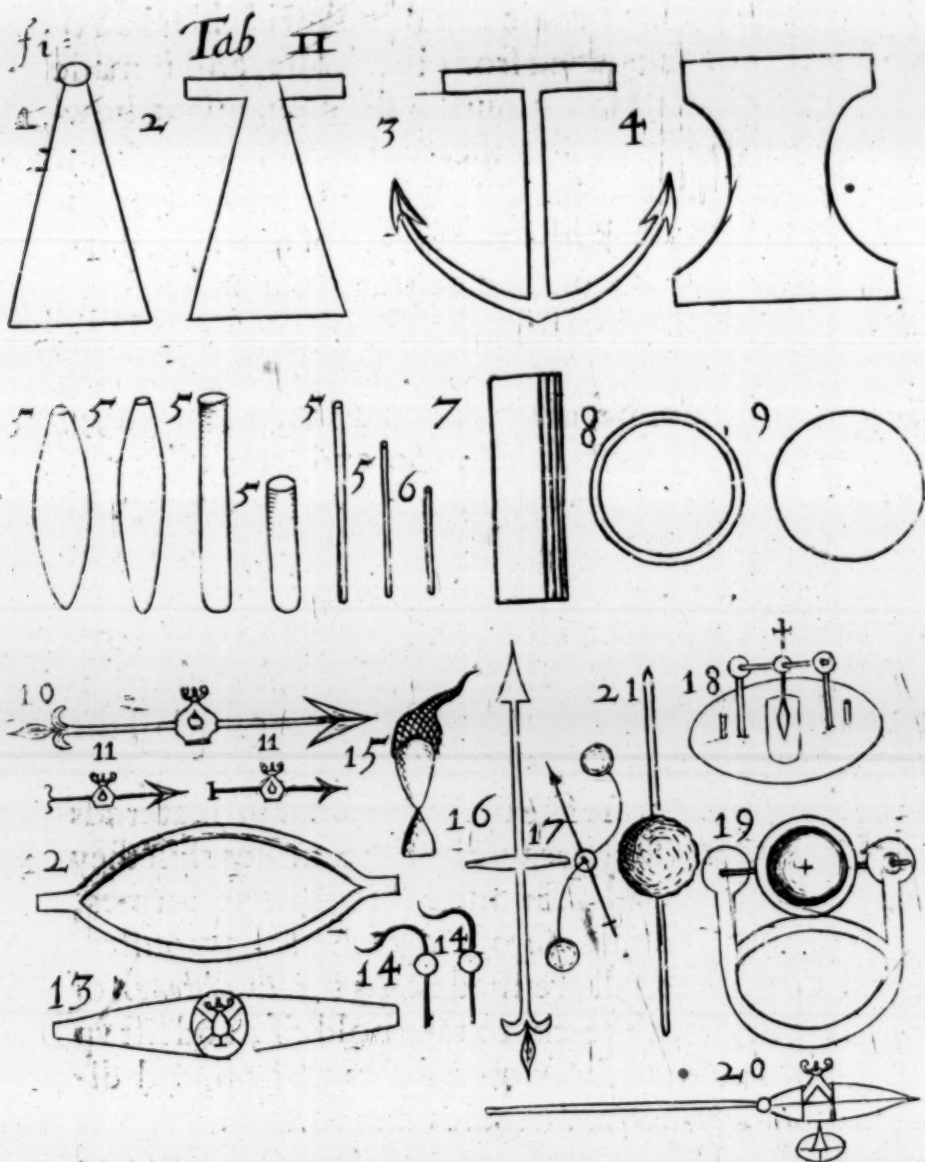
This mettall is heauie and of a blewish blacke colour after that it is tried from the drosse, and is made of certaine iuces and vapours in the conuenient bowels of the earth by a specificall vertue working him. Besides the mine this mettall is excocted out of diuerse stones, sands, earths and clayes of diuerse colors, which haue much Iron-like matter in them.

If some clay be burnt in the fire, being of a long forme, cooling North and South, after being hung on a thrid in the aire, or put into a dish in the water, it will turne and moue it selfe too and froe, till it rest North and South, and some clay being burnt, will shew a little iron vpon his sides that was melted out of him, so that this *Magneticall* substance of iron is not very scant to be found: for in all countries and regions there is great store of this mettall, being the principall matter of the externall barke of the globe of the earth.

Steele and iron are the best *Magneticall* materials for *Magneticall* vses; because by the Smithes skill they will be extended and fashioned into diuerse formes, fit for the practise and vse of *Magneticall* demonstrations. Of this mettall are made caps for *Loadstones* of diuerse formes with teeth, to take hold of, and lift vp great and small fashions of waights of iron, and diuerse other *Magneticall* needles and formes.

Waights of iron are made of diuerse formes, as long and narrow at the top, *Tab. II. Fig. 1.* to be taken and lifted vp at one end of the *Loadstone*, and with one tooth. Others haue an headlesse crosse vpon the waight, as *Tab. II. Fig. 2.* long, and finely smoothed aboue, that the *Loadstone* may take the better hold with

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both his teeth. Some greater waights may be made in fashion of an ankor, *Tab.II. Fig. 3.* with a crosse head, or in forme of a sithe, *Tab.II. Fig. 4.* also you are to haue in readinesse longer formes of iron and wiers, great and small, as in *Tab.II. Fig. 5.* to apprehend a-  
lone,

lone, or one at the ende of another : also very small wiers of iron, the length of a barley corne, *Tab. II. Fi. 6.* are fit to set vpon the *Magnet*, for diuerse intents and purposes.

It is good to haue long plates of iron reasonable thicke, *Tab. II. Fig. 7.* round plates of iron, *Tab. II. Fi. 9.* and round rings of iron of diuerse weights and bignes, *Figure 8.*

It is conuenient to haue diuerse directory *Magneticall* needles, great and small, *Tab. II. Fig. 10. 11.* for dyals and instruments, and needles for Compasses, *Tab. II. Fig. 12. & 13.* to fasten to the Cardes, or to take off at pleasure : we vse short wiers fastened to thrids; and a little *Loadstone* in a thrid to take vp a waight.

Also it is necessary to haue *Inclinary-needles*, *Tab. II. Fig. 16.* to put into his ring, and a short one with a Lute-string in the middest, *Tab. II. Fig. 17.* or else put in a frame of brasse or siluer, as *Tab. II. Fig. 18.* to find the pole of the *Loadstone*, and to demonstrate his oblique inclination to the *Loadstone*, as he is caried about him, or else to haue a little round *Loadstone* put into a frame with an axletree, hauing his poles marked *Fig. 19.* which applied about the *Loadstone*, turneth and conuerteth it selfe diuersly, also it is fit to haue a short and thicke needle, *Tab. II. Fig. 20.* into the end of it, there is to be put a wier of siluer, brasse, or of a peece of a Whale-bone, for vses hereafter to be declared. Also a long wier thrust through a corke, *Fig. 21.* serueth for *Magneticall* vses in the water. These formes of iron, with others that the ingenious will easily inuent and make, are very fit for *Magneticall* demonstrations, as well as the variety of *Magnet* stones are.

## CHAP. IIII.

*Of the Earth.*

His great Globe of the Earth whereon we moue and trauell, is found to be a *Magneticall* body, by such as haue trauelled and sayled round about her, as Sir *Francis Drake* did, and *M. Candish*, whose *Magneticall* Compasses were alwayes directed *Magnetically*, that is, the Lilly of their Compasses was turned alwayes towards the North-pole in all places wheresoeuer they sayled, by the vertue *Magneticall*, and disponent faculty of the *Magneticall* Globe of the Earth, as it is demonstrated in the XXV. Chapter of this Booke. Also by such as haue made their course northerly and southerly, it hath bin obserued that the *Magneticall Inclinary-needle* doth in euery eleuation of the pole conforme and apply it selfe, or rather is conformed and disposed vnto the *axis* of the Earth, according vnto certaine correspondent angles to the Latitude, as it is demonstrated in the XII. XIII. XXXV. & XXXVI. Chapters of this Booke, whereby it is demonstratiuely to be concluded, that the Earth is a *Magneticall* body, directing both her selfe and the other two *Magneticall* bodies into the North and South, by the vertue of her Meridian circles and parts, as is demonstrated in the IX. chap. and others.

Moreouer, the Earth hath naturally two *Magneticall* poles, vnto the which these meridionall parts do direct,



rect, bend & force, not only *Magneticall* bodies neere the Earth; but also her owne mighty and massie situation, stability and firmenesse, and seateth her selfe so strongly vpon her two poles, by her naturall and *Magneticall* vigor, passing from her meridionall parts to the poles, as if she were tied by many mighty strong cables vnto two most firme pillars, farre stronger then any *Hercules* pillars, not to be remoued by any force from her naturall position; which thing, if it might chance that it should come to passe, yet certainly she would returne againe vnto her former firme seate and place, as all *Magneticall* bodies and directory needles do, as is demonstrated hereafter.

Thus we proue that the Earth is placed and firmed by her *Magneticall* vertue, and not by her grauity and waight, though that the parts of the Earth do conioyne and adhere together by their grauity mouing to their Center. But the *Magneticall* nature moueth, conformeth, and firmly seateth it selfe to the poles and *Axis*.

Now for that the poles of the Earth do alwayes, by their natural vertues hold the Earth North and South in one certaine and vniforme situation, eleuation and place, there is no doubt but that the whole globe of the Earth, inwardly stored with many materials and rich minerals, & outwardly adorned with many trees and exerescences, all for the vse of man, with liuing creatures innumerable, as also in reason it is an vnfallible certainty, that the Earth hath, at her first creation, bestowed vpon her a globous and starlike vigor, or intelligence, whereby she may, hauing her whole parts vnited together, by the vertue of grauity vnto the center, and her place made sure *Magnetically* by her

poles vnmoueable; yet moue naturally, keeping her place circularly & diurnally out of the West into the East, to the end that all creatures should receiue the comfortable and liuely beames of the Sunne, and the influences of the rest of the Planets and Starres.

This motion many learned men haue attributed vnto the Earth, for the benefit of calculating the motion of the Planets the better, which naturally she hath in her selfe; for euen as it were needlesse for a wheele to haue her naue, spokes and rimme about her, if it should not be vsed to turne about; so it were to no purpose that the Earth should naturally haue a globous body, two poles, an *axis*, meridians and æquator, as shall be demonstrated hereafter, parts fit for circular motion, and not for to turne her æquator and paralels about, as the wheele doth.

Although these arguments will hardly perswade vs to belecue the earths motion; yet because that it is lately obserued vnto our senses by helpe of the trunckespectacle, both by *Galileus* and *Kepler*, famous Mathematicians, that the great body of the globe of *Iupiter*, being twelue times greater then the Earth, doth turne about in lesse time then a day vpon his *axis* and poles, who also haue obserued foure Moones, attendant on *Iupiter*, which moue round about him, the slowest in 14 dayes, the next in seuen dayes, and the rest in shorter time. So likewise *John Fabricius* hath obserued, that the great globe of the Sunne, hauing three great spots, like continents in him, and being sixty times greater then the Earth, to moue about his *axis* and poles neere the time of ten dayes, or thereabouts, so *Galileus* and *Kepler* haue seene the Planet of *Venus* to moue about the Sunne in ten moneths, and to haue her light from

from the Sunne in this time increased and diminished vpon her body; as we see the Moone here neerer vnto vs to haue; therefore it being certaine by obseruation, that the globe of *Iupiter* and the Sunne do turne about their *axis* and poles, whose materials we know not, we need not doubt that the Earth should haue a circular motion for her great good. But how the Earth doth turne circularly we cannot well see it, with the sence of our eyes, vnlesse we had them placed in another globousbody and starre, as if they were in the Moone; where we might see the spots of the Earth to turne about, as well as now we see the spots in the Sunne, and *Iupiter* to moue circularly in their place. And as contrariwise our eyes here on the Earth do see that the Moone doth not turne about, by the placing of her spots, alwayes in one fashion vnto vs: for we may obserue with our eyes, that the Moone hath poles of a kind of *Magneticall* nature, which do alwayes hold her to behold the center of the Earth, and so stayeth and conformeth her, that howsoeuer she moue, higher or lower, or wheresoeuer she be, yet alwaies the spots of halfe her globe be alike apparant vnto our eyes, and conforme her to behold the center of the Earth with one pole: neither doth the Moone turne about her body vpon two poles, as the Earth doth vpon hers, but is kept firme and vnmoueable from circular motion, about her *axis*, by other two poles that be vpon the edges and æquator of her body, because her spots be alwayes alike on her East and West side, that hold her firmly & stiffely that she can by no meanes turne about vpon her first two poles: For it is the vertue polar and *Magneticall* that holdeth all globes in their position whatsoeuer. Besides, the Moone hath  
another



another vertue giuen her at her first creation, whereby beholding alwayes the center of the Earth, and moving neerer and further from the Earth, as tied with an axletree, she moueth, slideth, and passeth monethly about the Zodiacke, that all the parts of her globe may be illuminated and refreshed with the beames of the Sunne, and influences of the Starres: for as a ship vpon the water is directed euen forward by the sterne and ruther, which hath not only a right line to direct forward, but also a right angle descending downwards, that she waue not sidelings or turne about, yet hauing this position, if ankors be layd out, either forward, or backward, or sidelings, with their cables on boord, if there be force or vertue on boord to hale forward, she moueth forward, if drawne backward, she goeth backward, if pulled by the cable on the left hand, yet keeping her position, she betaketh to that hand, and so to other parts. Euen so the Moone being seated, as afore is said, doth moue on her *axis*, higher or lower, on this side or on that, according to the vertue & strength of the multiplicity of her axletrees, being her limbes to stay and moue withall, as the body hath armes and legges, with variety of muscles to moue on all hands.

But the Earth, whereon we liue and trauell, hath neuer bene found by any to haue any poles in the æquator of her body, or neere the same: for if we were so happy to find any in the East or West of the earth, then the matter of longitude would be perfectly attained vnto, which hath so greatly busied all the ingenious wits of the world: and therefore we affirme that the Earth doth turne about, because there are no poles in the æquator to hinder her, as there is in the Moone,



Moone from circular motion. But leauing these motions to others that do labour more therein, here in this booke I purpose onely to intreate of the great globe of the Earth, as she is a *Magneticall* body, which shall be first performed, by way of imitation, in a little *Magneticall* earth, or *Terrella* and *Semiterrella*, made of a round *Loadstone* and *Adamant*, whereby we shall plainly and sensibly demonstrate, that there be two poles, an *axis*, meridians, paralels, and an æquator in euery *Loadstone* and *Magnet*, and we shall produce many other pleasant demonstrations, manifest Theoremes, and sensible practises vnto your eyes and vnderstanding, which we shall after illustrate to be in the globe of the Earth, to proue it to be a third *Magneticall* body, different in substance from the other two *Magneticall* bodies, spoken of in the two former Chapters.

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CHAP. V.

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*Of the two Poles, and how these points  
are found out.*



The ancient Mathematicians and Astronomers of formes times, obseruing the diurnall motions and apparences of the Planets and Starres, fained certaine fixed poles, and other circles in the heauens, by which they discoursed of the risings, settings, motions, and of the places of the planets and starres; neuer imagining that these

D fained

fained matters were naturally and sensibly to be found in the globe of the Earth, much lesse to be seene naturally, and in a round *Loadstone*, and in all other formes of the *Magnet* stone, being long seuered and kept from touching and couching in the bowels of the Earth.

I will first proue how the two poles are found out in the *Magnet* stone, which are very necessary to be knowne, before that the *Load-stone* be fashioned into any forme, for the better proportioning of the same; and this matter may be accomplished fixe or seuen manner of wayes.

1. The first way is to role the *Load-stone* in small and cleane filings of iron, and about those parts where the points and poles be, there the filings will cleaue fast in great multitudes, and at the pole will stand and be erected vpright, marke these places with Chalke, Tripoly, Red-oker, or with an hard file for the poles.

2. The second way is to hang a sowing-needle by a thrid, or a small wier, *Tab. II. Fig. 14.* or as in *Table XVII. Fig. 1.* ouer those places of the *Loadstone* wherabout the poles are likely to be, and the needle and wier will moue from his perpendicularity, and hang directly ouer the point, and desire to touch the pole. So likewise, if there be a small peece of a *Load-stone*, *Tab. II. Fig. 15.* cemented to a thrid, and held so that one of his poles bend downewards, and it will affect to touch and to vnite it selfe to the contrary pole in the stone.

3. Thirdly, take the needle of a dyall, or some of the directory needles, before described, *Tab. II. Fig. 10. & 11.* place the same, being touched *Magnetically* vpon his pin or stake, *Tab. III. Fig. 1.* then turne the *Load-stone*

stone round about, holding it somewhat neere vnto the needle, and it will point at the pole of the *Magnet*, desiring to touch it.

Fourthly, take a peece of small wier, of iron or Steele, such as is made for Virginall-strings, *Tab. II. Fig. 6.* and cut off a part as long as a barley corne, and set it vpon the *Load-stone*, and it will sticke fast at one end vnto it, but erect it selfe at the other end, and being put forward, will stand vpright onely there, where the pole of the *Magnet* is, *Tab. III. Fig. 2.*

Fifthly, take a little *Inclinatory-needle*, before described, *Tab. II. Fig. 17.* that hath a Lute-string put through him, or take that *Inclinatory-needle* which is placed on a frame, and borne vpon an *axis*, *Tab. II. Fig. 18.* and cary either of these round about the *Loadstone*, and they will conforme themselves obliquely vnto the stone, and onely at the poles will direct the points of their ends perpendicularly ouer the same. Also take the litle round *Magnet*, before placed vpon his axletree and frame, *Tab. II. Fig. 19.* hauing his two poles marked, and this stone will turne and conforme it selfe to the *Loadstone*, and apply his contrary pole directly ouer one of the poles of the *Loadstone*.

Sixthly, place a small wier vnder the *Loadstone*, and it will follow to the pole thereof, and cleaue and hang to the pole it selfe, which is to be marked.

Seuenthy and lastly, take that wier that is thrust through a corke, *Tab. II. Fig. 21.* and put it in water, holding a *Loadstone* vnto it, and it will draw neere, and bend it selfe to ioyne to the pole of the *Magnet*.

If a stone be diuided and sawen in two parts from one pole to the other, or by a paralell, *Tab. III. Fig. 3.* the poles will be in their paralell place, *Tab. III. Fig. 3.*



*ab*, and are to be found in the middest of the substance of the *Loadstone*, vnlesse they be drawne aside by excrescences and leuities.

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CHAP. VI.

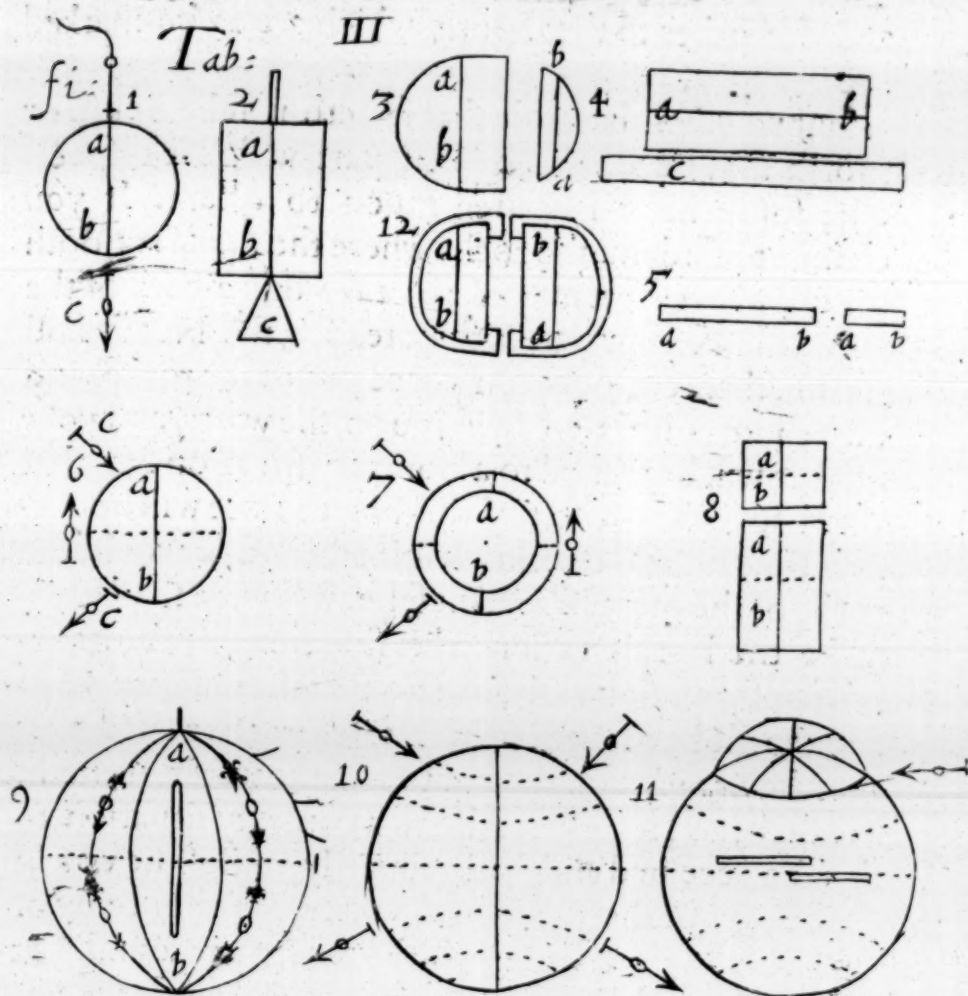
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*Of the vertue of the Poles.*



Here is no one part of the *Loadstone* that hath so great a vertue to attract, lift vp, and conforme *Magneticall* as the Pole hath. And although that some haue declared that all the parts of the *Loadstone*, from the æquator to the Pole, doe bestow their vertue and strength vpon the Pole; yet if triall be made what the Pole will take vp perpendicularly, and also what the parts about 34 degrees will lift vp, it will appeare to be more then halfe as much perpendicularly, so that the Pole doth not take vp so much as this, and the other part doth on the other side. Neither is it certaine that, according to the largeness of the cord in the arch, the attraction shall be in strength: for then the middle cords would be very strong, and stronger in lifting vp then the other; because their cords are curtailed at the æquator, which deuideth the *Loadstone* into two natures. But because *Magneticall* bodies do most apply and conforme themselues vnto the Poles, & make one straight *axis* with the center of the *Magnet*: therefore the attraction and apprehension at the Poles, is more strong then it is in other paralell places of the stone, where the *Magneticall* bodies conforme and apply





apply obliquely vnto the *Terrella*, whereby the attraction and apprehension in the spaces neere the æquator is weaker, and lifteth vp lesser waights.

*Magneticall* bodies haue two poles or points, the one is North, and the other is South, which be knowne either by hanging a *Loadstone* leuelly in a thrird, or putting it in a wodden dish to swim in a basen of water, and then the one Pole will alwaies turne to the North,

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and the other to the South, which are to be marked accordingly.

But whether that Pole that seateth it selfe South or North may be termed by that part which it respecteth, some haue laboured much to cleare. If you chance to find out the rocke where the *Loadstone* doth grow, where you purpose to take out a part of the same, marke your part with notes for the North and South, then cut out your peece out of the rocke, and put it into a bole to swimme on the water, and your markes will be turned to a contrary situation, to that they had in the rocke, and the North note will be turned South, and the South North, and so would the rocke of the great *Magnet* it selfe, if it were so placed, make the like alteration in his situation, by the generall conformation and direction of the mighty *Magnet*, the globe of the Earth. Therefore the reason why that the *Loadstone* in the boat vpon the water, turneth, bendeth, and seateth it selfe to a contrary situation, to that he receiued and had primarily, whilest he was in the bowels of the Earth, and vnited with the body of the great *Magnet*, is because that euery peece and part of a *Loadstone*, being seperated from the whole whereof he was a part, is now become a perfect, complete, and sole *Magneticall* body, and is as it were, a little earth of it selfe, hauing all the proprieties *Magneticall* that the great Earth hath, as his two poles, meridians, æquator, and such like: and therefore according vnto the nature of *Magneticall* vnion, hereafter spoken of in the XXII. chapter, will in no wise indure, and cannot be suffered to match and seate it selfe as he did before, but thinketh it moue naturall, and a thing of more perfection and conueniency to turne his aspect

a contrary way, to that he had primarily at his first making and endowment with *Magneticall* vertue.

This alteration of policy is to be obserued likewise in *Magneticall* needles, and long peeces of iron that be touched, and animated, and adhere to that part of the *Load-stone*, which seateth it selfe North, which being at liberty and seperated from the *Loadstone*, will turne that part and end that was touched at the North pole, and seate it alwayes in the South, and it shall be sufficient for vse to know and marke with a note which is the North-pole of your *Magnet*, and which is the South-pole.

There is another vertue in the Poles of the *Load-stone*, and that is, that the South-pole turned downward, will take vp more then the North-pole will, and the North pole will erect a greater waight then the South part or pole will, as some say, *Tab. III. Fig. 2. a b*. But I haue alwayes obserued, that the Pole of the *Magnet* that seateth it selfe North, is alwayes the most vigorous and strong Pole to all intents and purposes: vnlesse he lacke the quantity and like substance the South part hath.

These Poles which be in the great *Magnet* of the globe of the Earth, haue a maruelous strong *Magneticall* power imparted vnto them, that they cannot be turned either higher or lower, or moued to the right hand or to the left, but hold the Earth continually in a true and certaine position and place, and would if any force or power should moue their great strength awry from the true sight and meridian latitude, returne to their right sight and place againe, and this is the true vertue of the Poles of globes, which the Sunne and *Iupiter* haue as well as the Earth kept.

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These Poles be most certaine and sure markes for all *Magneticall* bodies, conueniently caried to direct themselves vnto, *Tab.III. Fig.9.* as appeareth by our Compasses, which in all places of the world turne their Lilly into the North, whereby the Marriner knoweth what course to take. And the *Magneticall* Pole, & Poles of the world, both articke & antarticke, are all one and not diuerse, as some haue imagined, which haue lost both their oyle and their paines; and this is true, by the demonstrations and motions of the *Inclinary-needle*, although there be many momentary causes of variation.

These Poles hold the Earth certainly in her polar position, while she turneth her selfe about to receiue the Sun-beames, and influences of the starres and planets, for the generation and maintenance of all inferior bodies, vpon her, in her, & proceeding out of her.

Lastly, these Poles of the Earth, in certaine great number of yeares, haue naturally a little inclination in the polar circles of the Zodiacke, for the receiuing and moderation of the beames, lights, and influences of the starres, whereby the progressions and anticipations of the æquinoctiall, and the mutations of the greatest declination of the Sunne are perfectly vnderstood, to preuent the faining of many Spheres aboue the starres, as the ninth, tenth and cleuenth, and their impossible motions.

In fashioning the *Loadstone*, it is conuenient to make flat or roundish the ends of the *Magnet*, where the Poles are the better to cap and arme them with iron or Steele, to lift vp their conuenient waights, *Tab.III. Fig.2. & 12.* and as the most are, *Tab.I.*

At the Pole the *Inclinary-needle* doth not incline  
obliquely



obliquely to the *axis*, *Tab. III. Fig. 6.* as the needle *cc* to *a b* the *axis*, as in other places, but aspecteth the Pole directly and perpendicularly, as *Tab. III. Fig. 1.* the needle *c* respecteth the *axis b a* directly, & maketh one line with it.

Also at the North-pole that point of the directory-needle, and compas, that did behold the South of himselfe, being applied to the North-pole, doth turne, as some thinke, but this is true only at the æquator in the spaces between the æquator & the 34 degree, as is demonstrated in the XII. chap. & not at the Pole it selfe, and the places neere adioyning: for at the North-pole, if the *Magnet* be truly placed, that point that pointeth towards the South, doth point to the South directly, and in the places neere adioyning doth it obliquely. A wier touched *Magnetically* hath two Poles, as *Tab. III. Fig. 5.* the one end *a* is North, and *b* of the nature of the South.

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## CHAP. VII.

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### *Of the Axis.*



The *Axis* or axeltree of the *Magnet*, is a line that passeth from the one Pole to the other, by the center of the body of the *Loadstone*, and after this order there is an *Axis* vnderstood to be in the Earth, *Tab. III. Fig. 1. 2. 3. & 9. 10.* In fashioning of *Magnets*, if a peece be taken away parallel from the *Axis*, then in these two *Loadstones* the *Axis* with his poles will be remoued into the midst

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of the stone, as *Tab. III. Fig. 3. ab*, the *Axis* in either peece is in the midst of the stone, so whether that bunches be taken away from the *Loadstone*, or any cavities filled, the *Axis* will alwayes be placed in the midst of the most vigorous bulke of the *Loadstone*, as *ab* in euery figure.

It is said in the latter end of the V. chapter, that if a *Loadstone* be sawen in two parts, from one pole to the other, vpon the *Axis*, that the poles and *Axis* will be found in the midst of the bulkes of the two peeces parallell to the old *Axis*, *Tab. III. Fig. 3.* and the poles of the lesser peece will be altered.

Also when as a side of the *Loadstone* shall be made flat and parallell to his *Axis*, that side will attract, hold and vnite vnto him long peeces of iron fidelings and parallely, *Tab. III. as Fig. 4. c* the peece of iron is adioyned parallely to *ab* the *Axis*, as the pole erecteth perpendicularly to it, *Tab. III. Fig. 2.* the waight *c* is attracted plim-wise to the *Axis ab*. And also two *Magnets* somewhat long, in forme swimming in their vessels vpon the water, wil adhere and vnite in a meridian parallell to their *Axis*, *Tab. XI. Fig. 5.* that if one of their vessels be haled, the other vessell with the other *Magnet* his loading will follow, both being fast grappled together, so that they cannot part asunder.

Likewise, take two *Magnets*, that be armed with their teeth of iron or Steele, descending from these poles at right angles to the *Axis*, to take vp, with both teeth together, & haue their *Axis* both of one length, as *Tab. III. Fig. 12.* place the teeth descending from the South-pole, vnto the teeth that haue the vigor from the North-pole, and they will cleaue and vnite together as one body and *Loadstone* parallell-wise to the  
*Axis,*

*Axis*, and the one, though he be the weaker, will lift vp the heuier perpendicularly.

Also all *Magneticall* bodies, whether it be at the æquator, at the poles, or at any intermediall part, betweene these two, do all of them apply, conforme, and vnite their bodies together, according to a correspondency of their *Axis*; as shall be declared hereafter, and not with their center to the center of the others body.

If a wier be touched *Magnetically* at one end, the vigor will run through 'all the wier, or *Axis*, and haue a contrary vertue in the other end, the one North, the other South, and halfe the *Axis* will be of one nature, and halfe on another, *Tab. III. Fig. 5.* the end of the wier at *a* is of the nature of the North-pole, and the end at *b* is of the South-pole.

We sayd in the IIII. chapter, that the Moone doth alwayes turne one Pole of her body toward the center of the Earth, and moueth neerer & further from the same, as if that a long axeltree were passed through her body, & fastned in a ioynt to the center of the earth, on which she should make her *Epigeum* and *Peregeum*; in like maner, it is to be probably gathered, that the earth may naturally haue a *Helicall* & *Spirall* vertue to moue on the Cilinder of her *Axis* in *spirall* lines, not vnlike the arches of the longitude of the day, to performe the Zodiacall motion, partly illustrated in the XXI. chapter by the bead, in an instrument of rings for the finding of the variation, where the bead, as an earth, is placed in the *Axis*, higher and lower, according to Zodiacall direction, and *Magneticall* vertue will permit this *spirall* motion, like as the sap passeth in the earth from the North hemisphere, to the South prouince.



It is a thing worthy of better obseruation from the Truncke-glasse, to know whether the *Axis* of *Iupiter* and the *Sunne* be paralell one to the other, and with the *Axis* of the Earth, which is to be examined by the turning of the spots about.

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CHAP. VIII.

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*Of the Æquator.*



**I**N all *Magneticall* bodies there is an *Aequator*, or middle fence, that diuideth the whole body in the middest betweene the two Poles, like a middrift, into two equall parts, hemispheres, and prouinces: outwardly in the middle part in the greatest circumference from the poles, there is an *Aequator*, circle, or line, that deuidenth the North-part of the stone from the South part, as by a border-marke, so that if a directory-needle touched *Magnetically*, be conueyed to any part betweene this *Aequator* and the poles, presently the end of the needle that is of the nature of the other prouince beyond the line of the *Aequator*, will turne about from that part, and the other end of the needle that hath affinity and naturall conformitie with the pole of that prouince, will offer it selfe, as *Tab. III. Fig. 6. 7. 9. 10.* in the prouince of the North-pole *a* about the *Aequator* and pricked line, the bearded end of the needle doth only offer it selfe, and desire to apply and vnite to that part, but the crosse end of the needle wil flye from it; so this crosse end of the needle will only affect to behold the

the

the south province vnder the *Aequators* pricked line to the pole *b*, and the bearded end of the needle will shift away. This assertion is not only found to be true in the *Loadstone*, but also in other formes of iron and Steele, and in the great Earth it selfe. As take a round plate of iron that hath laine some time quietly without stirring, as *Tab. III. Fig. 6.* or a ring of iron, *Tab. III. Fig. 7.* and offer the sides of this plate, or ring, vnto the needle, turning them about, and the bearded point of the needle will respect the one halfe of these iron circles, and the crosse part of the needle, being of the nature of the other semicircle, will apply and haue respect thereto. Here in these iron formes the *Aequator* and liinit of the two semicircles, is better perceiued where it should be marked, then the poles are: for when the *Magneticall* needle is once past the bounds of the *Aequator*, presently he turneth about his other point that respecteth the contrary semicircle, or rather hemisphere, the which for distinction sake might be painted of a red colour.

Moreouer, if a directory-needle, or Marriners compass be placed neere the *Aequator* of a *Loadstone*, of these iron formes, or of the earth, they will situate themselues paralel to the *axis* of the poles, as *Tab. III. Fig. 6. 7.* and *Tab. VI. Fig. 1. Tab. VII. Fig. 1. 2.* and incline neither to one pole, or the other, being placed in a right sphere, where the poles lie in the Horizon, the needles standing in equall ballance with the Horizon, looking North and South, paralell to the *axis*.

Whereas it hath bene declared in the VI. Chapters before of the vigor of the poles, that the vigor and strength *Magneticall* proceedeth by little and little from the *Aequator* to the poles, increasing in their

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passage by the meridians vnto the poles, to the end to augment their vertue of retaining, & consisting most firmly and constantly in the North and South, whereby the *Aequator* of the earth is left voide of all vertue of consistence, and left free, or rather deprived of constancy and retaining of any firme situation, and remaining naturally, by reason of his great circumference and weake renitency, most apt and prone for circular motion, which by her star-like vigor and intelligence, hauing this her globous body so firmly fastened naturally in her poles, as it were in two strong pillars, and fitted in the *Aequator* and paralels, as in Chariot-wheels: for circumuolution turneth her selfe daily about from the West into the East, to meet with, and receiue the pleasant beames and influences of the Sunne, Starres, and Planets, for to cherish, comfort, and inuigor all those goodly creatures that be placed vpon her, grow out of her, or be bred and conceiued in her, as also for the continuall change and vicissitude of seasons, being a thing more naturall and fit that the earth should thus moue for her owne good, then that all the heauens should furiously moue to serue her.

It is to be obserued in fashioning of the *Magnet* stone, that when the *axis* of the same shall be cut shorter, that then the *Aequator* remoueth necessarily to the middest of the body of the *Loadstone*, as if a long *Magnet* should be sawne and deuided into two peeces, as *Tab III. Fig. 8.* vpon, or paralell to the *Aequator*, the poles will be in the middest of the stones, and the *Aequator* will also be in the middest of either stone, as *a b*, and the pricked lines be.

For euery peece and part of a *Loadstone* hath his  
poles



poles and *Aequator*, with the rest of the circles, as well, and as naturally as the earth, or any great *Magnet* hath, and will be deuided into two iurisdicions by his *Aequator*. though before all his part was but of one prouince and nature. Euen so if you part a needle, or long, wier *Magnetically* touched, in two peeces, the parts will haue their seuerall poles, as *Tab. III. Fig. 5.* the poles *a b* are in either part of the wier.

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CHAP. IX.

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*Of the Meridians.*



He Meridians be great circles drawne by the æquator vpon the *Loadstone*, or as may be obserued by the needle vpon the face of the Earth, from the one pole to the other, where they do all touch, as in the centers, *Tab. III. Fig. 9.* they be naturally in euery *Loadstone*, and in the earth, and are thus found out: for they be the pathes whereon all *Magneticall* motions are trauerfed and directed. Lay a wier of a reasonable length vpon the *Magnet*, as *Fig. 9. a b*, and it will turne and seate it selfe vpon a Meridian, and point to the poles, and if he be moued from the Meridian by any force, he will soone returne to the same againe, and by this wier you may marke out a Meridian; Likewise take a little directory-needle of a small diall, and set it vpon a small pinne with a foote, setting them vpon the *Terrella*, *Semiterrella*, or any *Magnet*, *Tab. III. Fig. 9.* and the needle will point towards the pole, make a marke, remouing the needle forward

forward, and make more, then ioine all the points together, which make a part of a Meridian, and being continued forward runne to the pole, so a small and short wier placed vpon the *Magnet* from place to place betweene the æquator, and the pole, will sticke fast at one end, and erect the other obliquely, and the seuerall places, being nored with chalke or emery, will set out a Meridian to the pole, at the æquator, being no longer then a barley corne, will lie flat to the stone, put him forwards toward the pole, and then he will erect himselfe a little, sticking at the other end vpon your *Terrella*, *Semiterrella*, or *Magnet*, put him more forward, and he will be erected lesse acutely, and about 34 degrees from the æquator, he will make a right angle with the *axis* of the *Magnet*, and being brought and placed vpon the pole, standeth vpright in one continued *axis*, with the *axis* of the *Loadstone*, *Tab. III. Fig. 9.* This variety of application to the *Magnet*, doth produce a certaine kind of motion *Magneticall*, which may be called the motion of inclination, conuersion, or conformity of one *Magneticall* body vnto another; but the little directory-needle demonstrateth this motion best, being caried about the *Terrella* and *Semiterrella*, as shall be demonstrated in the XII. Chapter following.

I haue spoken before somewhat as concerning the making flat of a side of the *Loadstone*, paralell to the *axis*, which is a Meridian line paralell thereto, whereby waight may be apprehended, *Tab. III. Fig. 4.*

Therefore hauing a *Magnet* stone first made flat at the ends, where the poles are, and after a side made plaine and straight, paralell to the *axis* for a Meridian, then you may forme the stone into what fashion you please,

please, as into a foure-square, into a figure of 5, 6, or 8 equall angles or sides, or into vnequall sides, as hath bene shewed in the first Table in many types.

Cut a part from a *Magnet* stone meridionally, and that end which was placed South when it was whole, being seuered, will turne North, though naturally at first it was the South point, as in *Tab. I I F. Fig. 3.* the poles *a b* in the little peece are turned contrary to the poles *a b* in the greater *Magnet*.

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CHAP. X.

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*Of the Paralels.*



He Paralels be circles and parts equidistant from the pole, and Paralell to the æquator, and do possesse the whole space betweene the æquator and the pole, as *Tab. I I I. Fig. 10.* these circles are pricked out, as the æquator is, and are found by the *Inclinary-needle*, being caried at one angle about the *Terrella*, and in all these places the small wiers, *Tab. I I I. Fig. 9.* and directory-needles, *Tab. I I I. Fig. 10* do apply their *axis* or line of length obliquely to the *axis* of the body of the *Magnet a b*, or of the earth.

For to find out these oblique angles in euery Paralel, and what correspondency they haue vnto them, there be diuerse operations, diagrammes, instruments, and calculations found out to demonstrate, and to know what angle of inclination will answer to euery Paralell: for in euery Paralell of the earth the *Inclinary-*

F

*needle*



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*needle* maketh a diuerse angle of inclination to the *axis*, but one angle, and of one sort, in one and the same eleuation of the pole or Paralell, and by this meanes of the *Inclinatorie-needle* in a ring, the latitude of the pole is knowne on both sides of the æquinoctiall, without any sight of the Sunne and starres, by the *Magneticall* disposition from the earth.

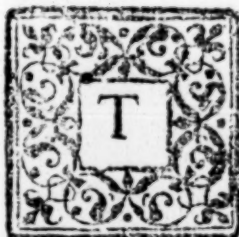
If in forming of the *Loadstone*, some Paralels be cut away, as it should seeme in the *Terrella*, by cutting and flattening the end where the pole is, *Tab. III. Fig. II.* yet in truth they remaine still vpon the *Magnet*, though the Meridian lines be changed from crooked lines to straight lines, and this is to be obserued, that alwayes the Paralell neere 34 degrees in the perfect *Terrella*, *Semiterrella*, and round Meridian, or straight Meridian, where the directory-needle aspecteth, that edge, or angle, at right angles, vnto the *axis*, *Tab. III. Fig. II.* and *Tab. VII. Fig. 2.* as the most protuberant and middle place betweene the pole and the æquator, as in this *Load-stone* truncated and flattened at the pole.

In the Paralels of like distance from the pole, all *Magneticall* bodies do apply and conforme alike, and haue the like inclinations of their *axis*, that denotate like eleuations of the pole, and do attract and retaine with like forces and vertue, *Tab. III. Fig. II.*

Place two wiers vpon a Paralell of the stone, as you would say East and West, and they will not conioyne or vnite together, *Tab. III. Fig. II.*

Rub the needle of a dyall Paralell-wise on the *Load-stone*, and it will hardly be excited and animated, vnlesse the touching be neerer vnto the pole.

## CHAP. XI.

*Of the Horizon.*

The *Æquator*, the *Meridians*, the *Parallels*, the *Poles* and *Axis*, are all naturally in the Globe of the Earth, and in every *Magneticall* body, and not imaginary in the heauens, as Astronomers heretofore haue thought, not knowing in what body to find them naturally. Now it remaineth to write of the *Horizon*, which is a great circle that deuidenth the Globe of the Earth into two hemispheres, or into two equall parts, like as the *æquator* doth deuide the *Magnet* into two prouinces, and though that the *Horizon* be of great vse in *Magneticall* practises; yet I cannot affirme that the *Horizon* is naturally in the Earth, or any other *Magneticall* body, as the *æquator* is, onely every point and place vpon any meridian and paralell may be the center of the *Horizontall* circle, which center is *Magneticall*, and of many vses in *Magneticall* demonstrations, both to know on what paralell and eleuation of the pole, aboue the *Horizon* the inclination and conformation of the *Inclinary-needle* is obserued, whereby we come to the knowledge of the angle that inclinatory maketh with the *Horizon*, in every paralell of the earth, and by a correspondency that it hath with the *axis* of the eleuation of the pole we come to know, as hath beene sayd, the latitude of the pole in all places of the world, without the vsuall helpe of the celestiaall bodies, hauing as

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certaine an helpe from the materials of the Globe of the Earth, and their vigor for this conclusion, as from any other globe whatsoeuer.

This center of the Horizon also is the place whereon the Pilot placeth his Compas, and composeth the same leuellly and parallelly to the circle of the Horizon, so that by the firme direction of the Lilly of the Compas to the North, he knoweth which way to steere his ship to the desired port.

The Horizon therefore of vse is a plaine and parallel superficies vnto the horizontall circle it selfe, and is to be deuided into 360 parts, from which lines are to be drawne to the center of this horizontall circle, and may be called the lines of position, verticals, and Azimuth, whereof one of them is of principall note, and is called the *Magneticall* meridian line, from whence the rest are to be numbred, and by which we are helped to knowe the declination of the Marriners Compas from the true meridian of the world, which thing is commonly called the variation of the Compas. For although that naturally the directory and *Magneticall* needle, or Compas, should place it selfe vpon the true meridian, by the disponent vertue of the *Magneticall* globe of the Earth, yet by reason of the neighbour-hood and approching of other eminent, forcible, and great *Magneticall* continents, this needle is turned awry from the true meridian and varieth, and declineth to the one side or the other, certaine parts and degrees to be reckoned vpon the horizontall circle.

Whereas it is sayd by some, that the horizontall circles make alwayes right angles with the *axis* of the earth, this assertion cannot alwayes be true, but this  
circle



circle of the Horizon maketh alwayes a right angle with the meridian, whereon he standeth.

CHAP. XII

Of the two circles that the Needle maketh about the Magnet.

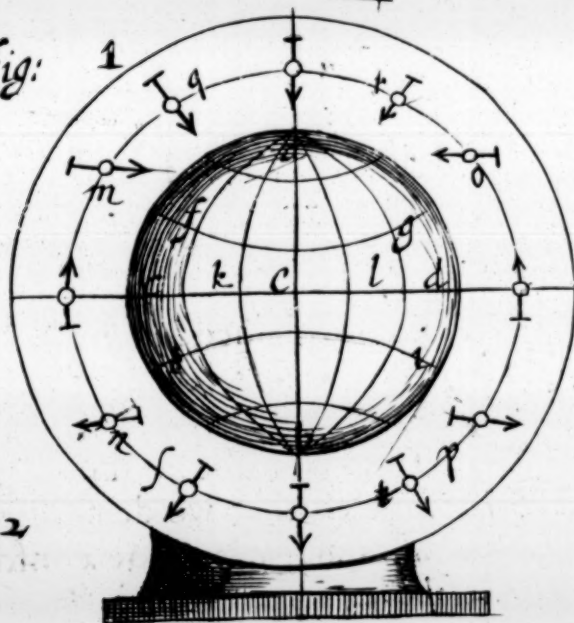
**H**Auing explained before the nature of the poles, the *axis*, and the circles, and parts of the *Magnet* to be naturally in the same, and in the globe of the earth; Now it followeth that we demonstrate how the *Magneticall* needles and wiers doe conforme themselves to the meridian of the round *Magnet*, whether it be a *Terrella* or *Semiterrella*.

For this purpose it is very necessary to haue these formes truly rounded, to be caried artificially vpon a foote, and fitted within the head of the same, in a circular and hollow cauitie, that may receiue the stone, so that the two poles of the *Magnet* do lye leuell with the Horizon, leauing a thin ring of the foote about the stone, vnder which there is a shoulder, a quarter of an inch thicke, left of the abatement of the height of the foote round about, to beare a round verge or limbe of past-boord, brasse, or siluer, for a meridian or right horizontall circle, as is vsed to be done in the placing of all globes in their frame or foote, whereon may be made diuerse situations of needles, and descriptions *Magneticall*, as *Tab. IIII. Fig. I.*

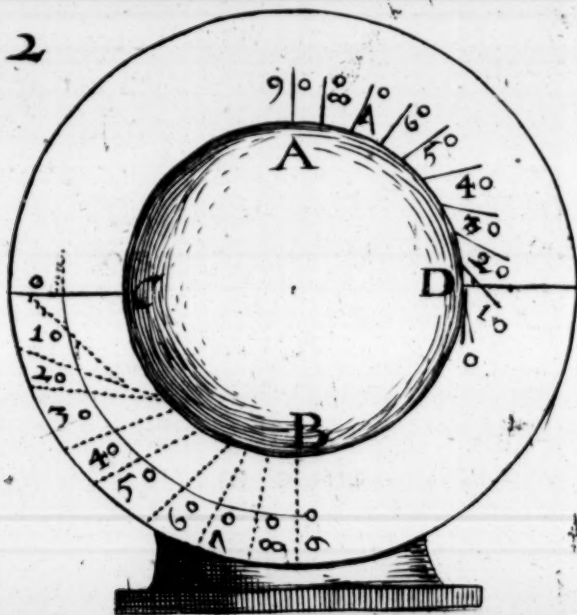
In the first figure *a b c d e*, is the round *Magnet*, *a* the

Tab: III

fig: 1



f: 2



North-pole, *b* the South-pole, *a e b* the *axis*, *c e d* the æquator, *a k b* and *a l b* the meridian circles, meeting at the poles, and *a c*, and *b d* the meridian, or right horizon, hauing the poles in it, *f g* and *h i* be two parallels. The *Magnet* being thus adorned outwardly, as it is indowed inwardly, after place the needles, being before touched, on the limbe out against the poles *a b*, and they do aspect the same directly, making one straight line with the *axis* of the *Magnet*, then set needles in the verge against the æquator *c d*, and they will carry themselves in a paralell syte to the *axis* of the stone, and looke neither to the one pole nor the other: so that hereby you may gather that there is a semicircle betweene euery one of these 4 needles. Now to find out the quadrants of these semicircles, apply needles in the limbe at *m n o* and *p*, which letters be about 33. deg. 58. 13. // distant from the æquator, on each side on him, and they will be situated at right angles with the *axis* of the stone, where these eight needles haue eight quadrants betweene them that is 4 semicircles, which make two whole circles, one on each side of the æquator: for the reason hereof I will giue you a conceit at the latter end of this booke. And if you place needles in the middest, betweene the æquator and the poles, as in *q r s t*, they will behold the æquator, but will respect the *axis* obliquely, as in all other places and parts, except in the eight places before mentioned.

The better to vnderstand this foresaid demonstration, I would wish you to haue in readinesse a little directory-needle, with a foote flat and round, and a pinne in the center of it, to carry the needle, as in the third type of this IIII. Table. Let this circular foote  
be



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be deuided into foure parts and quadrants, with lines crossing each other at right angles in the center *o*, where the pin that carieth the needles, and at the beginning of euery quadrant set these figures, at the first 1, at the second 2, the third 3, and the fourth 4, now in the limbe, free from all needles, set downe this needle with his foote at the æquator *d*, and the needle will seate it selfe paralell to the *axis* of the *Magnet ab*, then turne the foote of the needle about, that the diamiter of the figures 1, 3, may be directly vnder the needle, thus in this syte carry the foote and this diamiter of the needle alwayes paralell to the *axis* of the *Magnet*, and place it in *m*, where it will point ouer the figure 2, the beginning of the second quadrant hauing finished one quadrant of circumuolution about the foote or epicicle, then carry this foot with the needle with this diamiter paralell to the *axis*, as before, and place it against *a* the pole, and the needle will point to 3 the figure of the foote: hauing finished halfe the epicicle of his foote, then remoue the foote with the diamiter 1, 3, paralell to the *axis* of the *Magnet*, and rest it at *o* in the rimme, and the needle will point at 4, hauing perambulated three quadrants, and then rest him at the æquator *c*, where he will point to the figure of 1, againe, hauing finished a whole epicicle about his foote, in this iourney about halfe the *Magnet*: so likewise if the needle be transported beyond the æquator to trauell by the other pole *b*, to finish another epicicle, the point of the needle, that is of affinity with this iurisdiction, will offer his seruice, whereto place the figure of 1, to stand iust vnder him at the æquator *c*, which here likewise will be situated paralell to the *axis* of the *Magnet*, and the foote being in this sort æquidistant-

æquidistant-wise to the *axis* conueyed in the limbe to *p*, the pole *b* to *n*, and lastly to the æquator *d*, againe the needle in this hemisphericall part of the body of the *Magnet* will describe another epicycle about the foot that carieth him, so that it is most apparent that the needle in his circūambulation about the *Magnet*, doth turne himselfe twise about, and make two whole circles, or epicycles in this voyage, as hath bene demonstrated.

Whereas the needle in his progresse from *d* the æquator to *m* is but almost 34 degrees from the same, in which space he maketh his first quadrant, but the way from *m* to the pole *a*, is almost twise as large, in which he maketh another quadrant, it is necessary that this circumuolution of the needle from the æquator *d* to *m* not 34 degrees, should be much more sudden and swift, being in so little a space of the quadrant *d a*, then that forming of a quadrant by the needle vpon the epicycle of his foote when he passeth from *m* to the pole *a*, being a space almost as large againe, and therefore the mouing of the needle in making the second quadrant of his foote, should be almost twise as slow as the finishing of the first quadrant, if like time be allotted to both their passages. I thought good to set this needle and foote in the III. figure, vpon the limbe in the next *Tab. V.* which will serue also for the demonstration in the chapter following.

Yet it may be noted to the contrary hereof, the case being altered, that if there were a cutting away made of part of the paralels about the pole, and that the pole were made flat and plaine, as it hath bene shewed *Tab. III. Fig. 11.* that then the application of the needle at right angles, to the *axis*, at the angle and edge

of the *Magnet*, being the most protuberant place, and the needle would describe but one quadrant from the æquator to this angle, and the other quadrant of the needles conuersion, betweene this angle and the pole, would be on the flatted end; and then in this truncated body, the motion from the æquator to the angle, for the first quadrant would be very slow, and the motion for the second quadrant would proue far swifter.

Now for *Magneticall* attraction and apprehension, it is to be obserued, that at the poles the *Loadstone* doth attract and retaine *Magneticall* bodies perpendicularly and most strongly, and at other places most weakly and obliquely, and neerer the pole more strongly. But where the poles be flatted, as is sayd, and the application at right angles, there the erection of waights is altogether as strong as at the poles, taking vp in parallel-sort vnto the *axis* of the *Loadstone* by two teeth, and at right angles by one tooth.

Lastly, for the vse of the application of the *Inclinary-needle*, I haue set downe a second figure, and in the margent haue delineated out in pricked lines, what application the needle hath, and maketh in euery tenth degree of the quadrant, from the æquator to the pole in the limbe of the quadrant *CB*, as likewise in the quadrant *DA*, there is set forth how the small wier and short erecteth it selfe in euery tenth degree in that quadrant, a thing hereafter more plainly demonstrated by a diagramme in the XXXVI. chapter, by calculation, and by ring, but indeed the matter will be more naturally and truely demonstrated in the chapter following.



## CHAP. XIII.

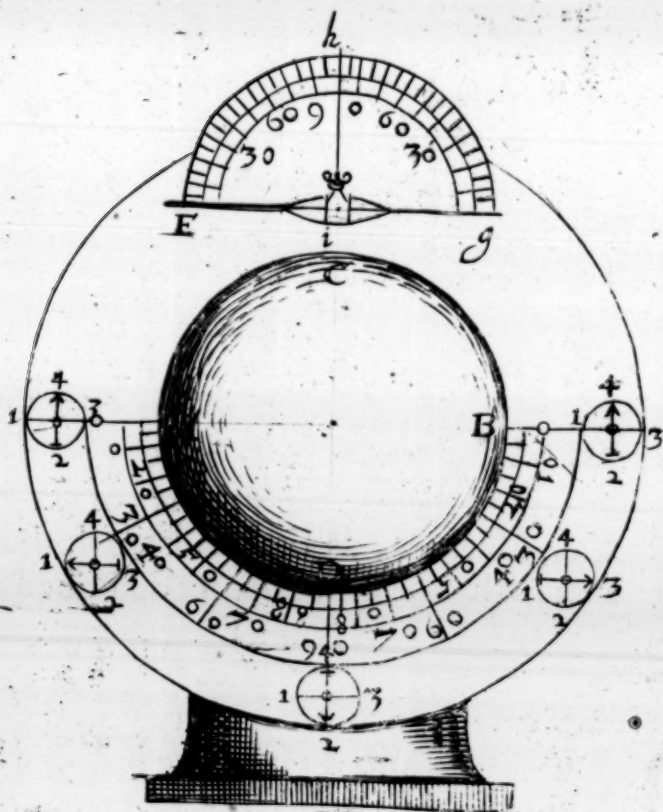
Of one circle the Needle maketh round  
about the Magnet.

Even as in a semicircle if sights be ap- ENC. 3. Prop. 20.  
plied to the diamiter, and a plim line  
fastened to one end of the diamiter,  
this semicircle will serue onely for the  
vse of one quadrant, though it haue  
two quadrants contained in it, so this

Chapter will abreuiate the motion of the needle in  
the former Chapter, as the quadrant doth the semi-  
circle that in the former Chapter described two cir-  
cles about the *Magnet*, and shew a way and deuice  
how the needle, being alwayes caried about the *Mag-  
net*, shall make but one circomuolution about the  
circle of his foote, although before he made two cir-  
cles about it, and this demonstration is of most neces-  
sary vse for to find out the angles of the *Inclinatory-  
needle*, with the *axis* of the Earth in euery eleuation of  
the pole, and what they are from the Horizon, and  
knowing what number of degrees they include in any  
place, the altitude of the pole in the same place shall  
be accordingly knowne.

It is conuenient for the performing of this demon-  
stration, to haue a verge and limbe for the sayd *Load-  
stone* mounted vpon his carriage, as before, somewhat  
loose, not fixed, that it may the more fitly be moued  
and turned about the *Magnet*, I would it were furni-

Tab. V



shed with two semicircles after this manner.

In the *Terrella* or *Semiterrella* let the poles be *A* for the North, and *B* for the South, and the æquator *CD*, part the semicircle *ADB* into two quadrants at *D*, then make other semicircles in the verge without *ADB* for the degrees and figures in each quadrant, as is vsed to be done in other quadrants, then deuide each quadrant, and euery one of these into three other parts, then deuide these parts into smaller parts, and if the circle be bigge inough, deuide these last into five parts

parts a peece, and thus haue you either quadrant de-  
uided into ninety parts, then set the vsuall numbers of  
tens at euery tenth part to ninety, ending at *D*, as in  
this type, *Tab.V. Fig. 1.*

Then about a quarter of an inch aboue *c* in the verge,  
draw a line at *i*, at right angles to *CD*, and from *i* as  
a center describe vpward a semicircle to touch that  
line *FI G*, deuide this semicircle into two parts and  
quadrants at *H*, ioyning *i H* together in one line, af-  
ter draw other semicircles within the semicircle *F H G*  
for the degrees and other numbers, as you did in the  
former quadrants, then diuide each of these quadrants  
into 90 parts, beginning the diuisions at *F G*, and en-  
ding at 90 in *H*, then set the figures at euery tenth de-  
gree, as is vsed to be done. Lastly, vpon this center *i*,  
place the *Magneticall needle* vpon his pin, *Tab. II. Fig.*  
*20*, that is, the needle that is thicke and short, hauing at  
the one end an hole drilled, for to receiue a wier of  
brasse or siluer, to counterpoyse the thicke head of the  
needle, and to reach vnto the farthiest circle of the de-  
uisions of the two quadrants of this semicircle: this  
needle and semicircle would be couered with some  
glasse and slude, as dials vse to be couered, for a little  
aire and the breath of your mouth, when you looke  
neere to see what deuisions the taile of the needle cut-  
teth, will moue the needle and driue it away.

This limbe and verge thus furnished with these two  
semicircles, and this needle being placed about the  
*Terrella* or *Semiterrella*, so as it may very easily without  
any great force be turned about; in this situation of the  
needle, as it is in the type, the needle seeth it selfe at  
the æquator *C*, paralell to the *axis* of the stone *AB*; we  
will call the inner semicircle of the limbe *ADB*, that is



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next to the *Terrella* or *Semiterrella*, the meridian circle of the altitude of the pole; the outward externall semicircle *FHG*, we will terme the meridian Inclinary semicircle, because the needle Inclinary doth shew in these quadrants certaine parts and degrees, answerable to euery degree of the eleuation of the pole, of the *Terrella*, or *Semiterrella*, declared in the inner quadrants of altitudes of the pole.

For practise hereof, if it be desired to know where the pole is eleuated ten degrees aboue the Horizon, what degrees the *Inclinary-needle* will point at in the Inclinary meridian semicircle answerable thereunto. Here turne about the limbe and verge, vntill ten degrees of the semicircle of altitude be placed iust with the pole *A*, the pole being eleuated so many degrees aboue the Horizon, then looke in the quadrant of the meridian inclinary semicircle, and his needle will point to 20 degrees, the very true parts, the *Inclinary-needle* being placed in his ring and meridian circle, hereafter to be described, will point at in traueling where the pole is eleuated ten degrees, after this manner seeke out what will be correspondent where the latitude of the pole shall be 20 or 30 degrees, and this needle will point out the correspondent degrees of the angle of inclination in the meridian-inclinary semicircle, to these or any eleuatiō that shalbe desired.

Therefore here you see how profitable, and of what great vse this demonstration is, in helping to attaine to the reason & true knowledge of the *Inclinary-needle*, which placed in his ring, and caried about the earth in the meridian, doth only shew his angle and inclination to the *axis*, but this demonstration directeth from the stone it selfe what will be the number of degrees that

that the angle of the inclination maketh about the horizon, and what degree of the eleuation of the pole will be answerable thereto, and from hence Tables may be made and collected what degrees of the *Inclinary-needle* will be answerable to euery eleuation of the pole.

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CHAP. XIII.

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*Of the distance and Orbe of the  
Magnets vertue.*



Here is a certaine faculty in the *Magnet*, being round, or of any other forme that is sent out and dispersed from the limits of his body, which be, and make as it were a spheare, and orbe of *Magneticall* vigor and power, where within *Magneticall* needles and bodies being placed in any distance within the farthest limit and border of the same, do conforme themselves in that place of the orbe, according to a circumference of their semidiameters, from the center of the *Terrella* or *Semiterrella*, to the center of the needle, which needle is alwayes in euery part of this circumference, conformed and situated as proportionably as if this orbe of *Magneticall* vigor from the *Loadstone* were a materiall *Magnet*, and the needle beholdeth that pole with his point that hath affinity with the same, and also maketh the same angles with the *axis* of his circumference, which other needles do in the same arches & places, whether they be in an orbe situated neerer the *Terrella* or *Semiterrella*,





*terrella*, or further off, so that the conformities of these *Magneticall* bodies are not so fashioned as if the *Loadstones* and *Adamants* drew and attracted all *Magneticall* bodies to be situated according to the measure of his owne small *axis*. But in these orbes *Magneticall* needles are moued, incited, disposed, and conformed in all correspondency, as if these orbes were materiall spheres. For the setting to view of this demonstration, it is conuenient to haue a large limbe and verge about the *Terrella* & *Semiterrella*, as in this type, *Tab. VI. Fig. 1.* describe the letters about the *Terrella* or *Semiterrella*, *AB* the two poles, and *CD* the æquator, from the center *E* make three circles, or more, in the limbe or verge, at an indifferent distance one from the other, for the distinction of these orbes, within the vigor of the *Magnet*, then at these orbes where they crosse the *axis* and æquator produced, place certaine *Magneticall* needles, which being placed vpon the *axis* will presently all of them make one line with the same, and such as be set at the orbes of the æquator, will settle themselves paralell to the *axis*, & at right angles to the æquator. But these peradventure thus placed, do not demonstrate the orbes so well as I would, which therefore I shall set downe needles in the middle places betweene these two diameters, and all these will behold the center where the æquator-line crosseth their owne orbe, and be paralell one vnto the other, as you may see in this Table, *Tab. VI. Fig. 1.* I haue set foure wiers *FGHI* vpon the body of the *Loadstone*, and these do erect themselves in this outward superficies of the stone in such order that a line drawne from them, doth directly behold the æquator *CD* of the *Magnet* it selfe. Also to demonstrate this demonstration to your sence



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the better, I haue set downe in two orbes needles at *KLMNOPqr* at about 34 degrees from the æquator, where these do in these orbes-seate themselves at right angles to the *axis*, and paralell vnto the æquator, beholding one the other in the same orbe and prouince in a right line, as if euery orbe were a solide *Magnet*. So likewise such needles as be placed in the middest of the quadrants in the orbes behold the æquator of their proper orbe, as others placed aboue the æquator behold the pole of their orbe.

Place a wier, about an inch in length, within their length in the orbe of a good *Magnet*, and they will skip vnto the *Magnet*, as though they were quicke, and will vnite and adhere fast vnto it, vntill they be taken off.

The celerity of motions, attractions, and conformities within the *Magneticall* orbe is according to the goodnesse of the *Loadstone*, the greatnesse of his bulke, conueniency of his figure, and smoothnesse, and in the shortnesse of the distance in the aire, or in water; yet further then in these the *Loadstone* extendeth his vertue by contraction and continuation in a long wier set vnto his pole, which wier will moue a needle, or adhere to another wier at the end of his length; but this is done by augmentation of the *Loadstones* vigor, as shall be declared.

Although that such substances, which be not *Magneticall*, be placed betweene the needle and *Loadstone*, yet they cannot hinder the orbe and proceeding of the *Magneticall* vigor, as if a *Loadstone* should be inclosed in a boxe of wood, stone, tinne, siluer, or brasse, yet the *Loadstone* will extend his *Magneticall* orbe, wherein many pretty and ingenious *Magneticall* practises may

may be wrought admirable to behold, as hauing the formes and protractors of creeping things, beasts, footmen, horsemen, and flies drawne in past-boord, hauing but a short wier closely conueyed into them, and placed vpon a trencher, paper, or plate, shall be caused to moue, stirre, passe on, and flicker, as though they were alieue, onely by mouing the pole of a good *Magnet* directly vnder them.

Also if a *Magnet* be fastened in the rooffe, or ouer a doore, it will hold an iron waight in the aire, *Tab. V I. Fig. 2.* that hath a thred fastened to it to hold it short that it be not drawne close for to be vnited vnto the *Load-stone*.

Likewise if a short peece of iron, or cap, be held within an inch of a strong *Magnet* stone, *Tab. V I. Fi. 3.* it will take vp great waights in this orbe, though not so much, as if it touched the stone and pole: but if the cap be held ouer the pole, it will hold a waight vp rather then the pole, *Tab. V I. Fig. 6.* I hold it needlesse to demonstrate how all the needles of dials, *Magneticall* instruments, the Marriners compas, and inclinatory-ring do all of them moue within the orbe of the *Magneticall* vigor of the earth, onely I will shew you a pretty practise or two for delight. Get a wier of foure or fise inches in length, and thrust it through a corke, then it being touched with the *Loadstone*, place it in a basen of water, and it will moue and direct it selfe North and South, by the vigorous orbe of the earth, *Tab. V I. Fig. 4.* and also incline and conforme a conuenient angle with the Horizon and *axis* of the earth. This practise is profitable for trauellers, who hauing fowing needles touched, may pricke them vpon any peece of wood, and place them in the water, and it will

set out the North and South instead of a compasse: but if for pleasure-sake you take another wier, thrust through a round corke, and let his vpper end be touched at the contrary pole, and placed in the bason of water, these two after some time will take knowledge of each other, and will begin to moue and stirre, and draw neerer and neerer together, *Tab. V I. Fig. 5.* and comming neere, will moue the faster, and suddenly ioine together at the vpper ends, on these wiers paper-tilters on hors-backe might be fastened, and they would runne their course together vpon corks in the water, &c.

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CHAP. XV.

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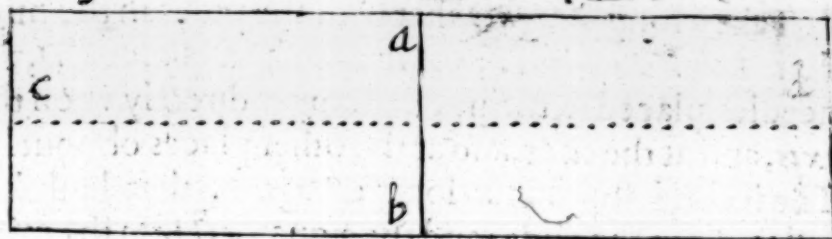
*Of Applications.*



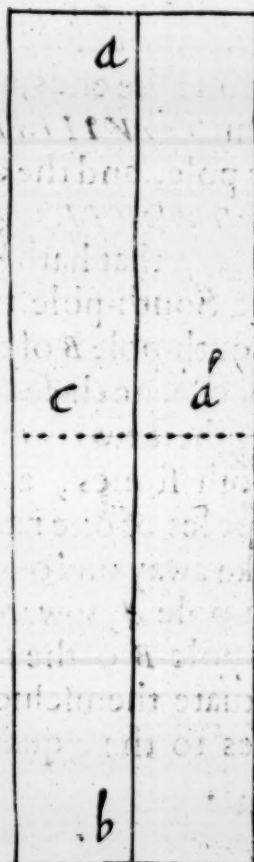
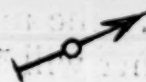
Haue demonstrated in the three former Chapters the conformities and applications that *Magneticall* wiers and needles haue vnto the meridian of the round *Terrella* & *Semiterrella*, which may be appropriated vnto the great *Magnetisall* globe of the earth it selfe. Now in this chapter we are to propound vnto your view certaine practises *Magneticall*, and applications vnto long *Magnets*, and formes, that haue the poles in the ends, or in the middest where the needles do vary and alter, as they shall be applied vnto them seuerally, or betweene two of them that haue the poles in the ends, or else in the middest, which peradventure may be of some vse in sailing or traueilling amongst some mountainous

fr 1

Tab VII



2





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tenous *Magneticall* eminences on the earth.

Take a long *Magnet* that hath the poles in the midst, *Tab. VII. Fig. 1.* as *AB*, and the æquator *CD*, the needles, placed in the midst, apply directly vpon the *axis*, and at the ends, and at the other places obliquely. The second stone is a long *Magnet*, that hath his poles *AB* in the ends, and the æquator *CD* in the midst, *Tab. VII. Fig. 2.* here the needle against the æquator standeth at right angles vnto it, and paralell vnto the *axis*, but at the either end of the *Loadstone* the needles apply themselves at right angles to the *axis*, and paralell to the æquator, and in the intermiddle spaces the needles apply obliquely to the *Magnet*.

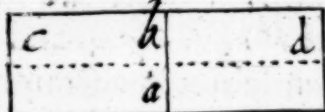
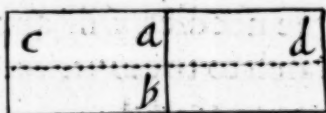
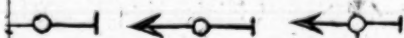
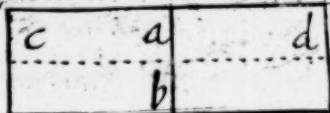
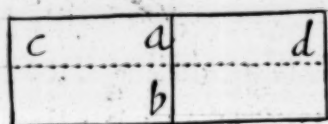
Now I would haue you to provide two long *Loadstones*, that haue the poles in the midst, like that *Tab. VII. Fi. 1.* and before him place three *Magneticall* needles, two at the ends, and one against the midst, or pole, as in *Tab. VIII. Fig. 1.* the middle needle will behold the pole, and the other will apply obliquely, as before in *Table VII. Fig. 1.* now bring neere the second *Loadstone*, that hath his poles in the midst, and place *B* the South-pole toward the needles that behold the South-pole *B* of the first stone, and these needles will, betweene these two South-poles, respect neither pole of these two stones, but seate themselves paralell to both stones, and make right angles with these two poles of one nature, as *Tab. VIII. Fig. 1.*

Now take away one of these stones, and after turne the North-pole *A*, towards the needles that behold the South-pole *B* of the other stone, and they will all of them situate themselves equidistant-wise, and at right angles to the æquators of both stones, as *Table VIII. Fig. 2.*

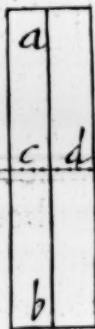
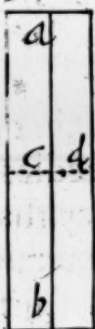
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fig. 1.

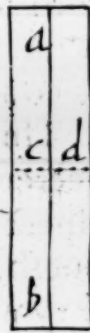
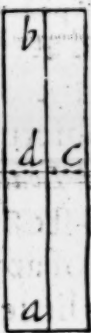
Tab. VIII



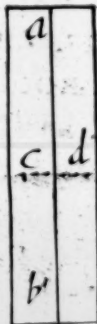
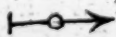
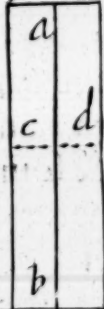
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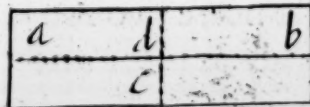
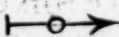
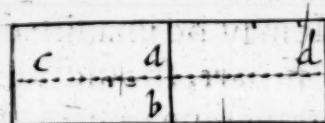
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6



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Moreover, take other two *Magnets* that are long, with the poles in the ends, like that *Tab. VII. Fig. 2.* and lay it before you, and place three needles before it, two at the end, & one in the midst against the æquator, which will apply paralell to the *axis* of the stone, and those two at the ends will seate themselves at right angles to the *axis*, as before; then set the other long *Magnet* that hath his poles in the ends with the North pole *A*, against the North-pole *A* of the first stone, *Tab. VIII. Fig. 3.* and all the three needles will apply themselves in a straight line paralell to the *axis*, somewhat like the order of the first type, yet contrariwise.

Now take away this second stone, with the poles in the ends, & turne it, and place the South end *B*, against the North end *A*, as *Tab. VIII. Fig. 4.* and then the 3 needles will stand at right angles to the *axis*, and paralell one vnto another, and to the æquator.

This is to be obserued in these applications, that the neerer the second *Loadstone* is placed to the needles, in aspect with the first *Magnet*, the better will they shape out these figures of applications, & in the approaching they will vary, by little and little, from their first situation, vntill the vertue of the two *Loadstones* be equall in their orbe.

It may be imagined that these applications, for the most part, should be found naturally vpon the earth in traouelling or nauigating betweene two great Ilands or high *Magneticall* continents, but the first & fourth figure of this eighth Table cannot be found naturally in any place, *Tab. VIII. Fig. 1.* and *Fig. 4.*

There is also much variety of variation in one needle neere two *Magnets*, or a *Magnet* and *Magneticall* body, as place a needle on a little foote vpon the *Terrella*,



*rella*, *Semiterrella*, or *Loadstone*, and it will direct it selfe rightly vpon the meridian of the stone, as hath bene proued before, *Tab. III. Fig. 9.* but if you hold a little peece of iron toward the point of the needle, the point will flie from the iron, and deflect from his meridian a little. Yet let this peece of iron touch the *Load-stone* and be vnited vnto it, and put it towards the needle a farre off, and the needle will turne from his meridian, and decline and vary towards it, the contrary is to be sayd, if this iron be put towards the taile of the needle.

Now take two long *Magnets*, that haue their poles in the end, and place a needle before the æquator of one of them, and it will apply paralell to the *axis*, then bring the other *Loadstone*, and place the end where the pole is against the æquator of the first *Loadstone*, as *Tab. VIII. Fig. 5.* and then the needle will vary his position, and seate it selfe at right angles, to the *axis* of both *Magnets*.

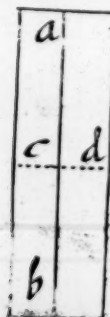
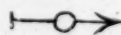
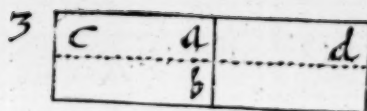
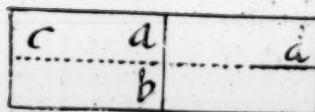
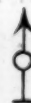
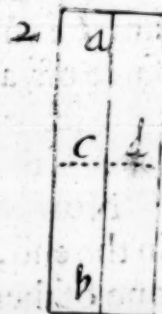
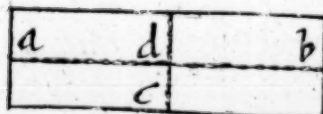
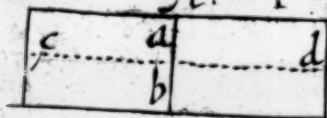
So also take two *Loadstones*, and let one of them haue the poles in the middest, and the other in the ends, and you shall behold much artificiall variety of the application of one needle vnto them. Place a needle before the middest of the *Loadstone*, that hath his poles in the middest, and it will behold the pole: after lay downe the other *Magnet*, that hath his poles in the ends, and set his æquator against the needle, and it will vary his position, and stand paralell to the æquator of the former *Magnet*, whose pole he beheld before, as *Table VIII. Fig. 6.*

Apply a needle to the end of a *Magnet* that hath his poles in the middest, where it will place it selfe obliquely vnto the stone, then place the æquator of the *Loadstone* that hath the poles in the end, *Tab. IX. Fig. 1.*

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Tab. IX



vnto the needle, and it will vary paralell to the *axis* he first beheld, and at right angles to the *axis* of the second stone.

Set a needle against the end of the *Load-stone*, that hath his poles in the ends, and it will rest it selfe at right angles to the *axis*, then apply the second *Magnet* to the needle that hath his poles in the middest, *Tab. IX. Fig. 2.* and the situation of the needle will be altered to be paralell to the *axis* he beheld at right angles at first.

Place at the corner of that stone that hath the pole *B* in the middest, a needle, and it will apply obliquely, then lay the end of the other *Loadstone* that hath the pole *A* in the end, and the needle will apply at right angles to the *axis* of both the stones, as it is *Table IX. Figure 3.*

But set a needle afore the end of the stone that hath his pole *B* in the middest, and set the end of the other *Magnet* that hath in the end the pole *B* of the same denomination, as *Tab. X. Fi. 1.* and the needle will apply, as is to be seene in the type in a straight line to the last, and paralell to the *axis* of the first.

Also apply the æquator of this second stone, that hath the poles in the endes vnto the needle, placed as afore, vnto the first stone, *Table X. Figure 2.* and the needle will be paralell to both *axis*, let the needle stand against the corner of the first stone obliquely, and apply the end of the second stone with the pole in it, *Tab. X. Fig. 3.* and the needle will apply, as in the *Tab. IX. Fig. 3.*

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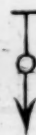
c	a	d
	b	

Tab: X

b
d c
a

2

c	a	d
	b	



a
c d
b



3

c	a	d
	b	

a	d	b
	c	



## CHAP. XVI.

*Of preserving the vertue of Magnets.*

**H**Auing treated of the parts of the *Magneticall* bodies, of their motions, and applications, now we will speake of his other naturall vertues and properties.

Some haue thought it very conuenient to keepe the *Loadstones* in filings of Steele and iron, to preserve their vertue and vigor, thinking that the *Magnet* is fed, or, at least, very much refreshed with them, because they will cleave so fast to the sides neere the pole; But I do not allow this way so good to preserve them, rather I like the keeping of them in a bag, or cloute of woollin-cloth, close from the iniury of the heate and cold of the weather, or in a case or boxe fit for them, and it is very necessary to wipe them often from dust and grease, and to haue a care that they do not rust.

Also it is very commodious and naturall for them that they be layde vp, and placed according to that naturall situation the which they would affect and respect, if they were caried in a place and fashion free from renitency and resistance in the aire or water; therefore they would be laide vp, or hung accordingly as their poles and pointes do particularly respect, to the North and South, which will comfort them exceedingly.

Besides, if the *Loadstone* be sometimes polished, it will strengthen and releue the body of the *Magnet*.

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very much. If a weake *Magnet* be rubbed at one of his poles with a stronger *Loadstone*, he will be bettered by it in his vigor and vertue, if not augmented therein.

Set a *Magnet* of no force or strength, that can easily be perceiued, vpon a *Loadstone* of good strength and vigor, especially vpon his poles, and he will shew a vigor, as if he were as strong as the *Loadstone* is, whereunto he is vnited, but after that he is taken away, he will be as weake as before, vnlesse it be often done.

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### CHAP. XVII.

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#### *Of contributing the vertue Magneticall to Iron or Steele.*



He iron barres in windowes, being there placed North and South, do receiue a polar vertue, and directory faculty in time from the vigour of the orbe of the *Magneticall* globe of the earth, and hauing marked them with notes to know which end was South, & which North in the window, take them out and tye a thrid about the middest of them, that they may hang leuelly in the aire, and the end with the South note will turne it selfe into the North, and the other note will behold the South, contrary to their place in the window, where they were first animated *Magnetically*.

Likewise, if a long peece of iron be forged North and South, and laide by to coole in the same situation, he will be animated and indewed with a polar vertue, and

and moue in the aire, being hung in a thrif, or put in a boate on the water, and turne to the contrary pole to that from which he firft receiued the *Magneticall* vigour.

If a rod of iron, a wier, or directory-needle, be ouerheat in the fire, fo that they haue loft all *Magneticall* vigor to direct them North or South, yet let them be touched with the *Loadstone* at one end only, and they will be excited with a directory and polar vigour at both ends, and the one end of the femidiameter will be of the North, and the other of the South prouince and nature, and being placed according to *Magneticall* orders, will direct their points to the North & South, contrary to the pole that animated them with this vertue polar.

Also take rods of iron, wiers, and *Magneticall* needles, that haue neuer bin touched with the *Loadstone*, and rub them vpon the poles, caps, or teeth of the *Loadstone* at the ends, and they will be much refreshed, vigorated, and animated with the polar and directory vertue at both ends, both of the North and South-poles, as though they had a new life of quicknesse infused into them, and these shall refresh other needles that shall be touched with them, and apprehend and draw them away like captiues, and will not let them loose from them, vnlesse by force you seuer them.

The best way to touch, incite, and giue the polar directory and *Magneticall* vigour and faculty vnto needles & Martiners compasses, is to rub them from the middest of the needle where the æquator of their *axis* is vnto their points vpon the pole, cap, or tooth of the *Loadstone*, drawing them thus from their middle to the ends, vpon the cap, pole, or paralell neere the same,  
vnto



vnto the *axis*, or at right angles to it, the after draw the other end vpon the other pole, cap, or tooth, diuerse times, as afore, and these needles, wiers, and plates for compasses, shall be perfectly touched and vigorated.

In long *Loadstones* that haue the poles in the ends, if a wier be drawne paralell to the *axis*, from the poles end to the æquator, it will be incited with that pole.

It is doubted whether the touch and polar vertue will be giuen as wel from a paralell some distance from the pole, as from the pole it selfe, it is plaine, that from those paralels and parts, neere adioyning to the pole, the greatest vigour of politie *Magneticall* doth proceed, yet in paralels, neerer the æquator, it will be giue likewise, & the vertue directory will be very sufficient.

If you touch the needle amongst the paralels, it is the best way to rub the needles alongst the meridians towards the pole, rather then to rub the crosse the meridians, in a paralell manner, yet this way will giue the polar and *Magneticall* vertue also.

Some haue thought it better to touch compasses, and *Magneticall* needles, rather on the *Loadstone* then vpon their caps, thinking that the vigor and faculty *Magneticall* will continue longest that is giuen from the bare *Magnet* stone, the truth is to be obserued in time. Yet the cap and tooth giueth and imparteth a stronger vigour to the needles then the bare stone doth, because the vertue of the *Loadstone* is increased as much by the armor and cap as if his bulke simply were tripled.

Needles and wiers of Steele, heated to an height, and reduced backe to a blewish colour, will receiue a stronger touch, and retaine it ten times longer then iron will, howsoeuer he be hardned, yet iron is best  
for



for caps placed neere the stone.

That end of the needle, whether directory or inclinatory, which is to be touched, ought to be somewhat lighter then the other, especially for the North, and most vigorous touch end of the stone, because that the touching will sway downea little, and the needle hath two motions, one of direction, the other of inclination, and then the needles and compasses will play more leuell and æquidistant to the horizon for the sayd vses.

When any *Magneticall* needle or wier is touched from the North-pole, or tooth of the Adamant, that end of the needle will respect the North-pole of the *Magnet*, but being seuered out of the orbe of the Adamant, it will be directed into the South by the *Magneticall* vertue of the earth.

But if a round globe or ring of iron be touched with the North-pole of the stone, the place touched will haue the vertue of the South-pole, & the North-pole will be in the opposit part, and being seuered from the *Magnet*, it will not turne to the contrary part, as it falleth out in long *Magneticall* needles & compasses, as before.

If a ring of iron be touched, the correspondent pole will be in the opposite part, but if this ring be cut asunder, and made a straight wier, then both ends will haue the vigor of one pole onely.

Excite a directory needle at both ends from one pole, and they will both be of one nature, and looke what point was last touched, and that will turne, as if he onely were touched, and direct more surely, with lesse wauering too and fro, then the other touchings will, spoken of before.

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Let a long peece of clay newly burnt, coole North and South, and it will receiue power *Magneticall* from the earth.

Set two *Loadstones* with their poles of one denomination, at the ends of a peece of clay whilest it cooleth, and both ends will be of one nature.

If a long wier be touched in the midst by the *Loadstone*, and passed through a corke, and set for to swim in the water, it will wauer vp and downe vncertainely, as though it were not touched: but if it chance to rest it selfe towards the pole, in time it will be indewed with his vertue.

Set a peece of iron vpon a *Loadstone*, as you did a weake *Magnet* in the end of the former chapter, and it will haue a great force, but take it away from the stone, and almost all the vigor will be departed.

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### CHAP. XVIII.

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#### *Of augmenting the vertue of the Magnet.*



Here is a meanes found out whereby the *Load-stones* that will take and lift vp a very small waight, may by being armed with a corselet and teeth, be enabled to take vp more ounces with his armor, then he could, being naked and vnarmed, lift vp scruples and graines.

The first way is by fashioning caps of iron or Steele to either pole, as hath bene described, *Tab. I.* in the second

cond Chapter, whereby the *Magnet* will lift vp a great weight of Iron at one end perpendicularly to the *axis*, and after, if you turne the other end to the weight, it will by his force lift vp the same weight also, if the stone be good and of equall substance and fashon.

This way or arming is most vsuall, for those *Load-stones* that be of a long ouall forme where at the poles there is fitted and placed two concaue peeces of Steele, which are fastned and held close to the same by three or foure long narrow plates of siluer or brasse, not vnlike to that order which is vsed in tipping of cuppes with siluer, that be of Ostridge-egges, Indian-Nuts, Mace-wood, and Stone, which from the bottome to the verges and edging, haue siluer plates for to hold the edging and bottome together: some trimme their *Load-stones* all ouer with siluer, and guild both the siluer and the armour, ioyning altogether with pretty ioynts, as in a case to open and shut.

There is another way of capping and arming of *Load-stones* when they haue a side parallell to the *axis*, made straight, plaine, and flat, and the pole rounded or flatted in the end, such as are the *Semiterrella*, or halfe ouall forme. *Tab. I. Fig. 2. 4.* and of many angles, as in the types of the first Table, all these formes may haue their armour on the ends, where the poles are of such breadth, as shall be comely, but the larger they are, the better it is, and from these cappes to haue two square formes of Steele or Iron, like vnto teeth, a little descending lower then the bottome of the stone, of bignesse and length, as the bulke of the *Magnet* shall permit, these teeth because that they do descend at right angles from the poles, will iointly take vp great weights, *Tab. XI. Fi. 12. 13.* parrally to the





*axis* of the *Magnet*, and yet at one of the teeth *Tab. XI. Fig. 11.* will lift vp as much as any cap doth directly, and in one *axis* from the pole, the weights for this forme, ought to haue the heads of their weightes, like an headlesse crosse, as is described, *Tab. II Fig. 2. 3. 4.* Heere obserue what weight one of these teeth will eleuate in the aire, for both teeth ioynedly lifting and holding one weight together, will take vp from the ground foure times as much in weight. There be some *Magnets* that will take vp with two teeth, fixe times as much as one tooth shall, and one I haue seene that will take vp twelue times as much with both teeth, as hee will do with one tooth, these teeth are to be fastened to the stone, with plates of siluer or brasse, by the skilfull workeman.

Such *Magnets* as be made plaine at both ends, hauing the *axis* in the middest of the stone, *Tab. I. Fig. 5. 6. 12.* may haue their armour with teeth on both sides, two teeth on the one side and two on the other, these will take and lift vp with like strength on both sides.

More-ouer, the vertue of the *Load-stone* may be further augmented, by increasing the number of teeth and shaping them so, as that they may take hold with foure or fve teeth, as *Tab. I. Fig. 7.* and *Tab. XII. Fig. 11.* where the poles being in the ends of the stone, and haue had two teeth descending on either side, now the sides be turned, and these are also turned, in forme of a Greeke P  $\overline{\text{I}}$ , and the stone hath his force multiplied and is made to take vp with foure teeth, hauing two teeth descending from either end where the poles are, which two teeth, are of one nature, and the other two of another.



The other fashion for to take vp with five teeth, as it were a hand with five fingers, must haue the pole in the midst of the stone, which being made, the bottom must haue his cap, for this part, to haue three teeth, like a *Slawonian T* , as *Ta. XII. Fi. 12.* and the other cap from the top must descend with two teeth like a *Greeke P* , as in the type.

There is a way to cap the *Loadstone*, so that it shall take vp with eight teeth, vsing foure at one time; and foure at another, the stone would haue two broad sides where the poles are, and the teeth would bee in forme like a *Romane X.* or *S. Andrewes* crosse the center hereof would be placed on the pole, and the teeth artificially fastned.

If there bee two *Load-stones* that bee capped with their teeth descending from either end of like Diameter and length, then place these teeth together that be of a contrary nature, *Tab. III. Fig. 12.* and *Tab. XII. Fig. 10.* and they will vnite and adheare together, and if they continue thus some time, the weaker will lift vp a better weight.

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CHAP. XIX.

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*Of the decay and decreasing of the  
Magnets vertue.*





He vigour of the *Load-stone* is much diminished by the euill keeping of it, as when it is laid in the open aire against the heat of the Sun, and subiect to cold, and all change of weather, or

*axis* of the *Magnet*, and yet at one of the teeth *Tab. XI. Fig. 11.* will lift vp as much as any cap doth directly, and in one *axis* from the pole, the weights for this forme, ought to haue the heads of their weightes, like an headlesse crosse, as is described, *Tab. II. Fig. 2. 3. 4.* Heere obserue what weight one of these teeth will eleuate in the aire, for both teeth ioyntly lifting and holding one weight together, will take vp from the ground foure times as much in weight. There be some *Magnets* that will take vp with two teeth, fixe times as much as one tooth shall, and one I haue seene that will take vp twelue times as much with both teeth, as hee will do with one tooth, these teeth are to be fastened to the stone, with plates of siluer or brassee, by the skilfull workeman.

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laid vp, as some do, in a boxe with rusty fylings of Steele and yron, in a place neere a pan of char-cole to keepe it warme in winter.

There is nothing that hurteth the *Load-stone* more then the fire doth, for if the *Load-stone* be burnt in the fire it will leese all his *Magneticall* vertue and strength, the which may be a little restored by touching a good *Magnet*, and how weake so euer he be, he will be a conuenient *Magneticall* medium, to carry the extent of the *Magneticall* vigour to a farther orbe.

*Aqua fortis* will eate the *Load-stone*, and burne and mortefie him, as he doth eate into Iron.

The *Magneticall* Needle being touched and excited by the *Load-stone* will not pursue and point out the vaines of such Iron as be very stony and full of drosse, as not worthy the labour to be digged, because they haue little *Magneticall* matter and Iron in them, and if that part of the Myne of Iron be beate and stamped into powder, the *Magnet* will take vp very little of this dust, declaring the Myne to be nought, vnlesse the Myne be heat.

*Crocus Martis* wil not be attracted by the *Load-stone*, because his *Magneticall* vigour is cleane defaced and euaporated by the fire.

If a *Magneticall* Needle, lately touched and inuigorated by the *Magnet*, bee heated red hot in the fire, he will leese all his potency polare, and directiue faculty.

It is also conuenient to vnderstand, that hauing touched and animated a Needle *Magneticallly*, if contrary to this excited, the Needle be rubbed from the point to the middest vpon the pole of a *Magnet*, cap, or tooth; so any long peece of Iron, or Steele else, as knife dagger, or sword, which before would haue attracted and  
lifted



lifted vp *Magnetically*, other Irons of some weight by being thus rubbed backe againe from the point to the middest, haue that vertue taken away, which they receiued before from the *Load-stone*, and are as void of all vertue attractiue, as they were before they touched the *Magnet*, so that they neither will adhere or lift vp the least weight, which was nothing to that they would haue done being excited.

If two *Magneticall* bodies be ioyned together at their poles, these two poles that touch together, haue the nature of the æquator, and will not then excite a Needle or two, thus touching.

An Adamant doth loose much of his strength, if hee bee diminished, and haue any part of his body taken from him, especially if his figure was good before.

Some haue thought that certaine formes of the *Magnet*, which may be allowed for conuenient figures do lessen the *Magneticall* vigour, chiefly in their attraction, as a sphericall or plaine superficies in the poles, of globes, and of square and angulous figures, but these full and obruse superficies and flat formes at the poles do attract best with their cappes, and lift vp most, as hath bene declared in the eighteene chapter before, for this vigour proceedeth from the substance of the Adamant, better then in long and picked formes, which haue very little substance left about the poles, yet this assertion is partly true in such like formes of Iron, for in this mettle the long fashion is best.

A round plate of Iron to the pole, cap, or tooth of the *Magnet*, disperseth and diminisheth the direct extent of his vigour, like-wise a long plate, or square peece of Iron or Steele, *Tab. II. Fig. 9. 17.* applied to the

the two teeth of the *Load-stone*, doth deforme the figure of the body and depraue his vertue.

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CHAP. XX.

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*Of the Commutation of the vertue Polar.*



He Polar vertue is said to be changed, when as the North-pole is made the South-pole, and the South-pole altered into the nature of the North-pole in *Magneticall* bodies; this thing is effected, in a weake *Magnet*, by placing him a long time by a *Magnet* that is stronger, vnnaturally, which is done by adioyning the two North-poles, or the two South-poles of the two *Load-stones* together a long time, where the strong *Magnet*, will by his neighbour-hood take away that contrary nature of pollity that was in the weake *Load-stone*, and will make, and infuse into him that polar vertue, which doth naturally vnite vnto the pole of the strong *Adamant*, making that point and pole to be South which was North.

This thing is not onely experienced in two feuerall *Magnets* lodging together in one chamber and boxe, but also if you shall agglutinate and cement diuers *Magnets* of diuers strengths together, they will all of them be conioyned and vnited together, as if it were one stone and body, and may bee made and fashioned into a conuenient figure, and will be endued with one vigour *Magneticall* of one prouince, though separated they were of diuers polities and iurisdctions.

*Magneticall*

*Magneticall* needles and long formes of iron, as kniues, daggers, wiers, and such like, if at one time they be touched and excited with the North-pole, and made of his nature in all operations *Magneticall*, then another time let these North points be touched, as is vsed to be done with the South-pole of the *Loadstone*, this end now hath lost his former nature, and is made of affinitie and allegiance vnto the South-pole, and after if you shall bestow vpon him, by touching him againe at the other pole, the vertue of the North-pole againe, and then he will march vnder his banner, and looke by which pole he is last touched and relieued, he will remaine at his seruice alwayes after and beare his badge. Put clay of a long forme in the fire, after let him coole North and South, and it will receiue a polar vertue: after burne it againe in the fire, and let that end which cooled first North now coole South, and it will be commutated into the nature of the South, and the other North. Furthermore if a strong *Loadstone* be held somewhat neere such compasses and needles, as haue bene excited and touched with the vertue directory from the north by the *Magnet*, although they be in their boxes, yet the other end of the *Loadstone* will alter their situation, and the Lilly of the Compasses will be cleane turned, that that part and Lilly that should alwaies turne North, will either stand South, or else moue vp and downe vnperfectly, and weakly, hauing his first polar vertue changed for another, or else taken away.

This conclusion maketh many affraide to let two *Magnets* come too neere together, lest the one should rob the other, but this will not be effected presently in the *Loadstones* themselues, though that it be proued

L

soone



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soone to come to passe in the *Magneticall* bodies of Steele and iron.

If a directory-needle be excited at both ends from one pole, it will haue the vertue of that pole at both ends, but if both ends be rubbed backe from the points to the middest, on the same pole, both ends will haue the nature of the contrary pole, and if one end be passed from the point to the middest, that end will haue the nature of the contrary pole, and the other end will keepe his nature still.

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### CHAP. XXI.

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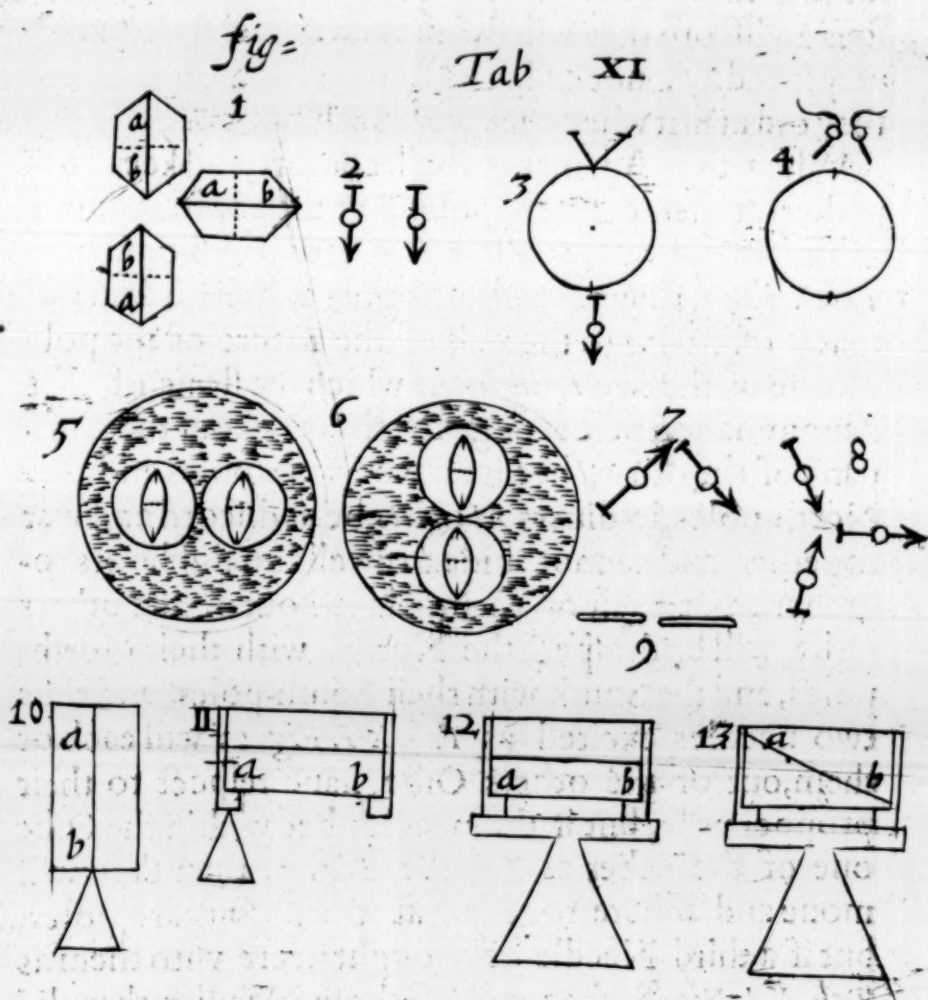
#### *Of the discord of the two Points of the Adamant.*



His Proposition is demonstrated by two *Magnets* swimming in their boates, in a bason of water, as *Tab. XI. Fig. 5. 6.* for if by force, their two North-poles or South-poles be placed together, they will abhorre the one the other, and part asunder by speedy flight.

If a smaller peece and part bee taken away from a greater *Magnet*, of whose body and bulk he was a part, animated, as it were, living and endued with one and the selfe-same life and vigour with the whole *Magnet*, like a child, that liueth and is nourished in his mothers wombe, as a part of the body of the mother, yet being seuered and taken out of the greater *Loadstone*, doth become a compleat *Loadstone* of it selfe, as a perfect  
new





new borne creature, with all the vigour and lineaments of his owne, belonging to a perfect *Magneticall* body, notwithstanding such is the nature of this little, and this greater *Magnet*, that their loue and agreement, in their vertues and points, is not such as it was in their vnion in one body, but their kind aspect, all one way is altered to bee at discord, and if you set South-pole to South-pole, and North-pole to North-pole, you shall

force them to tarry other-waies, like as if they were foes at discord they will swimme away and flie asunder very speedily, not enduring so to consort together as they did at first when they were both one body.

When two Adamants shall consort, and keepe together, at their contrary poles, at the approaching of a third *Magnet* they will be separated and flie asunder *Tab. XI. Fig. 1.* because that the pole of their Adamant, that is offered vnto them, is of the nature of the pole of one of the two *Loadstones*, which the stone of that denomination perceiuing, flyeth away from the company of the other, because two South-poles and two North-poles, in diuers *Magnets*, be at discord and war together, and cannot abide to dwell as neighbours together, but each of them, placed out of the others Orbe; will both aspect the North, with their North-poles, and the South with their South-poles, and thus two needles excited as *Tab. XI. Fig. 2.* will each of them, out of the others Orbe, haue respect to their proper pole, but if the needles bee within the Orbe one of the other as *Tab. XI. Fig. 7.* then they will moue and adhere together at their contrary poles, but if a third Needle be brought neere vnto them as *Tab. XI. Fig. 8.* then one of those Needles that did adhere, that had his pole of the same nature, with the pole of the needle that doth approach, doth cast about for to offer his other end of the contrary quality vnto it, and thus the first two Needles will aspect this third with their points of one denomination.

But this discord is not found betweene the Adamant, and the *Magneticall* Needles that bee excited and animated from one of his poles, for as long as the Needles bee within the view and orbe of the Adamants

mantes *Magneticall* orbe, so long they will behold and aspe& him with a certaine dutifull conformity, application and respe& vnto his *axis*, as it hath beene demonstrated in *Globous & Angulous Magnets*, but being seuered out of the Adamantine Orbe of the *Loadstone*, then they will flie, as from a foe, from that pole from whence they receiued their life and vigour *Magnetically*, and by the vertue of the earth conforme themselves to the contrary pole.

Contrariwise, take a large Globe or Ring of Iron, and touch them with the North-pole of the stone, and the animated place will haue the vertue of the South-pole, and adhere to the North-pole of the *Magnet*, and being seuered will keepe the same situation in the water, contrary to all Needles that turne the touched part to the contrary pole, as afore.

Set two short and slender wyars vpon the pole of a *Magnet*, *Tab. XI. Fig. 3.* and they will adhere at the lower end vnto the same, but whereas they should erect their other ends perpendicularly, those ends of the wyers will decline a great distance asunder, vnlesse by force they be vnited and ioyned together.

Contrariwise it will fall out if these two short wyers bee fastened to two seuerall thirds with wyer, and hanged ouer the pole, then neither of their ends will behold the pole, but for the hatred that the one beareth to the other, they beare off asunder in a great distance, desiring rather that their vpper ends, farthest from the, *Loadstone* should vnite, then that they should doe it.

Hold a knife to the Needle of a Dyall that is touched *Magnetically*, and the one point of the Needle will come to it and follow it, and if that the knife bee

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Offered to the other end of the Needle it will flie away from the knife, so one end of any wyer, though vntouched, will attract the Needle at one of the ends, and driue the other end away, Hereof more hath bene written in the sixth Chapter. Some thinke that this quality of the poles, thus to flie off the one from the other, that it is no enmity, but proceedeth from a disponent vertue, to cause these *Magneticall* bodies to moue and turne away, to the end that they may better frame and dispose themselues to a conuenient and naturall vnition.

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### CHAP. XXII.

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#### *Of Magneticall Union.*



*Magneticall-vnion* is when one *Magneticall* body naturally conformeth it selfe to vnite vnto any other *Magneticall* body, by conuenient angles & positions, that is, the South-pole of the one *Magnet* will apply and vnite vnto the North-pole of the other, as may be seene in *Load-stones*, carried in their boates vpon the water, and in *Magneticall* Needles and Wyers of Steele and Iron.

If two *Magnets*, or two Needles do vnite at conuenient points, a third *Magnet* or Directory Needle will first separate one of them till hee turne his contrary part, at the which hee will vnite with the third as *Tab. XI. Fig. 1. 8.*

There is a strong vnion, of body to body, and a weak, the strong coniunction is three manner of waies.

The



The first is commonly obserued to bee at the Poles, where one body *Magneticall* is conioyned and vnited vnto the other in a right line, vpon the *axis* at the pole, *Tab. XI. Fig. 10.*

The second strong vnion falleth out when the superficies where the pole is placed is made plaine, whereat the edges, *Magneticall* bodies adhere at right angles vnto the *axis*, as *Tab. III. Fig. 11.* and *Ta. VII. Fi. 2.* but more plainly, this strong vnion appeareth when as the Adamant shall be capped with two teeth at either pole, descending at right angles vnto the *axis*; for here a tooth will lift vp as much perpendicularly at right angles to the *axis*, as it will at the pole in a right line. *Table XI. Figure 10. 11.*

The third strong vnion, and strongest, is when at a Meridian in the *Loadstone*, there is a superficies made flat and plaine, paralell vnto the *axis*, where the coition according to the conformity in the æquator, inclining neither to one pole, nor to the other, is most strong, for whereas wyers and weights, at the pole, hang and adhere vnto it, but by one end onely, heere they will adhere alongst their *axis*, leaping more violently to adhere with their whole side and vnite, then they will from their endes vnto the poles, as *Tab. III. Fig. 4.* therefore the Adamant being armed artificially with two teeth, at right angles vnto the *axis*, will in this paralel conformity vnto the *axis*, apprehend and lift vp weights heauier by many times, then the caps at the poles will, *Tab. XI. Fig. 12.* because these receiue their vigour from the forces sent out of both Prouinces of the *Magnet*.

The weaker vnion of *Magneticall* bodies together is in the other parts of the Meridians, where the conformity

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formity and applications of their bodies is oblique to the *axis*, though that neere the pole, the oblique coition is stronger then it is by the æquator, Notwithstanding, there is an oblique coition, as strong as the strongest vnion, and will take vp as great weights, as the paralell vnition to the *axis* doth, and this is, as it were, a paralell coition also betweene the teeth and the head of the weight, yet oblique to the *axis* of the body of the *Magnet*, as *Tab. XI. Fig. 13.* hauing his supplies of strength from all the *Magneticall* body of the stone.

Vnition also, is either naturall, halfe violent, or else depraued; the naturall coition is when the vnion and conioyning of *Magneticall* bodies is by the contrary parts, as in Adamants, by the poles North to South, and in needles by head and taile, as *Tab. XI. Fig. 7. Tab. XII. Fig. 5. 6. 9.* so two wyers swimming on their corkes in the water, being rouches by contrary poles, will march and hasten to salute one the other, like two louers, *Tab. VI. Fig. 5.* Likewise in Adamants that be armed with two teeth, it falleth out that they will embrace the one the other, onely with the teeth and parts that be of contrary prouinces, and not with those of like nature and prouince. *Tab. III. Fig. 12. Tab. XII. Figure 10.*

The halfe violent coition, when as a small *Loadstone*, which hath bene taken out of the side of a greater, is placed in his former seate againe, where there is made a perfect vnion againe in one entire whole; so in the two short wyers that sticke vpon the pole, being heere vnited, but at the other ends flie off asunder, yet being put together by force, will adhere and haue an vnion and coniunction alongst their sides and Meridian



dian, as well as in the other way of vnition. *Table X I. Figure. 3.*

Now that vnition, which *Magneticall* needles touched and excited at the pole of the Adamant haue, may bee thought to bee halfe violent and some-what strange, *Tab. III. Fig. 1. 6. 7. Tab. IIII. Fig. 1.* because that heere there is an affinity of two *Magneticall* bodies of the same nature and denomination, and not of the contrary, that it seemeth that the *Magneticall* nature, betweene the Adamant and the Iron, is both very different from all other *Magneticall* bodies and some-what imperiall; for it is not to be seene either in *Magnets* one towards the other, though they be of the same rocke and peece, or in any wyers of yron or Steele of one towards the other, or in the earth it selfe, with those that she doth *Magnetically* animate, that that pole which is excited, or animated with a pole of the same nature, should respect and conforme it selfe, being artificially, without renitency, carried vnto a pole of the same nature and denomination, from whence he receiued his first vigour.

Heretherefore, no doubt, the Adamant is Masculine vnto his beloued the Iron and Steele, and these are Femenine, as more apt to obey, respect, and follow the Masculine, subiect to be attracted by him, whose presence quickeneth, reuiueth, and animateth them in all kind of vigor and commutation.

Thirdly, when yron is vntouched, and vnexcited, the coition is the weaker, but when a small peece of Iron shall be in a boate, with materials of other lading to be vnited to a *Magnet* in his vessell, heere the coition is depraued and weake, because the *Magnet* affecteth and draweth his owne beloued best, when she is

not



not laden or mixed with materials that be of different nature not *Magneticall*, and for this cause the Adamant will take vp a greater weight, all of Iron or Steele, then when a great weight of other substance, is fashioned to a small weight of iron or Steele.

The greatnesse of the bulke of the Adamant helpeth vnition, so doth the length of the *axis*, and vertue disponent to set the *Magneticall* bodies in conuenient situation.

Besides, there is a vertue attractive, besides the disponent vertue, and a directive and inclinatory faculty in the Adamants, that bring *Magneticall* bodies to vnition and apprehension, the two first retaine them in vnion and coniunction, proceeding especially from the goodnesse of the stone, the latter two helpe the disponent vertue, and are to be found in all *Loadstones*, and in the earth it selfe.

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CHAP. XXIII.

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*Of attraction Magneticall.*



*Magneticall* attraction is a naturall incitation and disposition conforming to contiguity and vnion of one *Magneticall* body vnto another, and no violent haling of the weaker to the stronger, being an appetite of vnity proceeding from both bodies that are separated, as two *Magnets* floating in their boates do not at first run together, as it were, from center to center of the bulke vpon a violent disposition or attraction, but the dispo-

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nent vertue first worketh, then the allicient and Adamantive vertue in them, both for vnition, doth shew his vigor to ioyne them by conuenient termes the one body vnto the other, *Tab. X I. Fig. 5. 6.*

Also the Adamant doth more strongly attract iron, hauing a more Masculine nature to attract her, and inableth her, bestowing vpon the iron, that ha roucheth, a great quantity of his strength without any losse vnto himselfe, so that shee hath power to attract other iron strongly, which before the excitation from the *Magnet* shee could not doe, and therefore excited formes of iron and Steele, are quicklier attracted, then such as are not touched, because they haue more *Magneticall* vigour in them,

Such *Magnets* as be armed with iron, attract more strongly then the bare stones doe, because that hereby their vigour is increased, being more strong, and extendeth it selfe further, as if a long iron wyer bee conioyned to the pole, or tooth of a *Loadstone*, and to the end of this, lay to another, and at the end of that a third, and so forward, the Adamant will hold them all, or most of them, according to his vigour and strength, *Tab. X I I. Fig. 1.* all touching one the other, and cleauing together, as linked in a chaine.

Place a wyer some-what short vpon a *Load-stone* neere the pole, or further off, and hold an iron or *Magneticall* body towards it, and the wyer will rather bee attracted away by this weaker body, and leaue this strong *Magnet*, *Tab. V I. Fig. 6.* and before the yron touch it, it will decline and bend towards the yron that approacheth, so will needles directory deflect awry, being placed vpon the *Magnet*, from their conformity to any vntouched wyer, and be attracted by them, and  
this

this proueth, that the eminent parts of the earth being *Magneticall*, may attract the Compasse to vary from the true Meridian of the earth.

The naturall attraction of *Magneticall* bodies, is that the North-pole do attract the South-pole, and the South-pole the North, although betweene the Adamant and the iron there is that sociability, that the North-poles loue one and the same pole.

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CHAP. XXIIII.

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*Of the strong apprehension of Magnets.*



He apprehension of *Magneticall* bodies is a strong vnion, cleauing and sticking of them together, that they will hardly be seuered, being strongly retained by the vertue and loue *Magneticall*, as though they were tied, glued, and soudred together, this coniunction and agglutination is performed by certaine conuenient positions, whereof I haue spoken in the XXII. chapter of vnion; according hereunto if two *Magnets* be swimming in their boates vpon the water, within the orbe and vigor *Magneticall* one of the other, they will moue to conioyne and be grappled together like two ships, and if one of the vessels be halled, the other will follow, *Tab.X I. Fig. 5.6.*

A strong *Magnet* will hold but a very small *Magnet* at the poles, hauing the North-pole applied to the South-pole, for to lift the small *Magnet* in the aire, but offer a wier of pollished iron or Steele, that is a



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good deale heauier then the fragment of the *Magnet* was, and the *Loadstone* will lift this vp from the ground and retaine it firmly, *Tab. XII. Fig. 5.*

If *Magnets* be of one mine, the biggest will lift vp and hold the greater waight, for this purpose the longer forme from pole to pole is best, and bulke being compared with bulke, this forme will take vp the greater waight, because his diamiter is longest.

Take a long peece of iron or Steele, as a knife, or dagger, or sword, that is finely polished, and touch and excite them *Magnetically*, and these shall take vp a greater waight of iron then the Adamant it selfe, so it be very good and little shall, that gaue them their vigor *Magneticall* to lift vp, and retaine firmly, *Table XII. Fig. 2.*

I haue a *Loadstone* that will vigoarate a sword to take vp and hold a pound waight. Likewise *Magneticall* needles and excited wiers will strongly retaine and adhere one vnto the other at their conuenient poles, hale one the other, and lift them vp, and retaine them firmly, for such *Magneticall* formes of iron and Steele as be touched and animated *Magnetically*, are sooner apprehended, held fast, and lift vp in the ayre then those that be vntouched and vnexcited, because that when the *Magneticall* vigour is infused, dispersed and spread through all the parts of the iron-waights, or of Steele, these formes are sooner vnited and faster tied, as it were, with strong ligaments and cords, both vnto the *Loadstone*, or one vnto the other, *Tab. XII. Fig. 3.* therefore if sand or other matter that is not *Magneticall* be fastened and bound vnto a smal peece of iron, or this small peece of iron be fastned to a paire of scales, that haue strings to the scales, though  
iron



iron be the waights of the scales : yet the *Magnet* will lift vp and hold a greater waight that is all-continued iron, then he will do of these mixture and intermission of *Magneticall* medium, of diuerse and different substances, not *Magneticall*.

If a *Magnet* be fastened to the pole of another *Load-stone* by his conuenient vpper pole then a greater waight then before will be apprehended by the *Load-stone* and taken vp, because that the *Load-stones* vertue is increased and augmented by the addition and adioyning of the other *Magnet*, *Ta. XII. Fi. 6. 9.* Euen so, for the same cause, if a wedge of iron be placed on the vpper pole of a *Load-stone*, the other pole that is downward will take vp a greater waight, *Tab. III. Fig. 2.*

If there be a thin plate of Steele or iron held or fastened vnto the nether pole of the Adamant, betweene the *Loadstone* and the waight, then the *Magnet* will lift double, and sometimes decuple, or ten times as much againe; from this practise begun and grew the arming and capping of Adamants with Steele and iron, after diuerse manners, *Tab. II.* and as hath bene declared in XVIII. Chapter, *Of the augmenting the vertue of the Load-stone*; by this arming of the *Loadstones* with Steele and iron in conuenient places, their vertue and potency is greatly multiplied, both to vnite, attract, apprehend, and lift vp greater waights, and also to moue, turne, and conforme *Magneticall* needles a far off, and the needles by hauing a strong vigour infused into them direct and retaine themselves more firmly in their conformitie and direction *Magneticall*.

If a plate or cap of iron be held to any paralell betweene the æquator and the pole, crossing in any meridian, there will be an apprehension and retention of  
iron.

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iron, wiers, and waights, much heauier then the bare vnarmed stone wil hold without this cap, *Ta. XII. F. 7.*

Where the superficies of the *Magnet* about the pole is flatted and made plaine, hauing armour applied to it, and a tooth descending from the point at right angles to the *axis*, here this tooth will take vp and lift as much as the cap at the pole will, *Tab. XI. Fig. 10. 11.*

Those Adamants that be capped to take, apprehend and lift vp at the pole onely, if there be three of them readily prouided, put the second to the nether pole of the first, and he will retaine him firmly, then adde the third to the nether pole of the second and the first, by vertue infused into the second, and the third, will strongly hold them both in the aire, *Tab. XII. Fig. 9.* all of them being armed and communicating their vigors together firmly to vnite.

So a dagger or sword excited, will lift vp one waight at the end of another, and if the vpper that touched the sword or *Load-stone*, be held an inch off, yet by the vertue that is extended within the orbe *Magneticall*, the waights will cleaue together still.

Set a short and small wier at the pole of a *Magnet*, and it will be erected, set another on this, and it also will be caried vpright, set on the third, and all three will be apprehended and borne vp, *Tab. XII. Fig. 7.*

Also set a short wier on the pole, and another on a meridian, not farre off the pole, or set them vpon two feuerall meridians, vpon a strong *Magnet*, then lay another short wier on their heads, & they will hold and carry it, and this also will carry another wier vpon his backe, *Tab. XII. Fig. 8.*

There be certaine formes of *Magnets*, as the *Semiterrella*, in fashion of an halfe boule, the long ouall made

made plaine at the bottome, the long square forme s, described, *Tab. II.* all these may be armed and capped with two teeth, at right or oblique angles to the *axis*, which being thus prepared, will apprehend great waights, and retaine them most firmly in the aire, *Tab. XI. 12. 13.*

If two *Magnets*, armed with two teeth apeece, be set before vs, the one being strong, the other weake, or much lesse, whose *axis* or diamiter betweene the teeth is equall of like length, then set the teeth of these together that come from contrary poles and parts, and the stronger will apprehend and lift vp the weaker, and the weaker being vnited and incorporated with the stronger, by the vertue that he receiueth frō the stronger, will lift vp from the ground, and retaine the stronger and greater very firmly, although he be much heuier then the waight, the small stone doth ordinarily lift vp, *Tab. III. Fig. 12. Tab. XII. Fig. 10.*

Let a *Magnet* be armed with two teeth descending, and two ascending, as *Tab. I. Fig. 5. & 6.* the vpper teeth will cleaue fast to a great waight of iron, and hold by the same firmly, apply a waight to the nether two teeth, and all will be retained and held together most firmly by paralell vertue of the meridians from the *axis*.

Such *Magnets* as be armed to one superficies, with foure or fise teeth, or more, *Tab. XII. Fig. 11. 12.* must needs apprehend more and greater waights, retaine and lift them vp most easily.

A peece of Steele well tempered, being excited, will lift vp a greater waight then the like forme and bulke of iron will, also this tempered mettall in a kinde of forme might be capped like a *Magnet*.



It hath bene proued that the apprehension is better betweene the bare stone and iron, as also the armed Adamant, with the armed Adamant, is most strongly retained, and farre more firmly then the retention of one *Loadstone* is with another small and bare stone.

Now it is to be obserued that Steele, by reason of his drinesse, retaineth his vigor *Magneticall*, bestowed vpon him, better then the iron doth that is softer, which entertaineth the vertue *Magneticall* sooner, and retaineth it the lesse time where his substance is lesse extensibile and glutinous; so Steele being very often excocted and euaporated in the fire, becometh very brittle, and will not receiue the *Magneticall* vigour, yet being reduced from that hardnesse, and easily tempered, not to be ouer hard, will retaine the vigour *Magneticall* better then iron.

Those Adamants are the best which are bare and naked without their furniture and armor to take vp their owne waights, or more, at one of their points and poles, and retaine the same firmly. Such Adamants will cleaue vnto a peece of iron by their meridian, and hang vnto it, and will retaine a great iron waight also adhering to the meridian paralell to the *Axis*.

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CHAP. XXV.

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*Of Magneticall direction from the earth.*



Hitherto I haue discoursed of the *Magnet*, and other *Magneticall* bodies, parts, motions, applications, vertues and effects, as they haue one vnto the other, which haue



haue bene of that qualitie, that they might be almost all of them experienced and obserued at home and in our houses, handling the *Load-stones* as little earthes and globes, and turning them about with our hands, to see, obserue, and vnderstand all the qualities, vertues and effects of the same whatsoeuer, comparing these *Magnets*, as diuerse earths and *Magneticall* globes together, with the motions, compassions, and conclusions, proceeding from a present, perticular, and vnnatural cause and potency in the stone before our eyes.

And hauing before partly discovered the motions that *Magnets* haue with the earth, being taken out of the same, and bred, and animated therein, as also the motions of such irons as haue bene excocted out of the mines, and such like veines, or rather bones of the Earth, that haue bene also endued and excited with the directorie and *Magneticall* vigour from the Earth, both at their first forging and forming, as also by their placing vpon the ground whilest they coole, and become tractable with our hands, and their position in houses, windowes and other places.

Also I haue shewed how this vertue directorie, polar, vigour, and politie is to be giuen to compasses for the sea, & to directorie-needles, that direct our mouable dials into the meridian line, and to the *Inclinatory-needle*, or any other needle or Mathematicall instrument whatsoeuer.

Now I am to declare how such demonstrations as haue bene learned at home out of the *Terrella* and *Semiterrella magneticall* may be put in practise and vse by such as saile to farre countries by sea, or trauell by land, for their great benefit, both to teach them how to direct their course, and to tell them in what place

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and climate they are in, which thing they may performe and learne very perfectly, hauing the directory in their compasses, and the *Inclinary-needle* in the meridian ring artificially made about them.

In comparing the two *Magneticall* bodies of iron, and the *Magnet* with the earth, the great and mother-*Magnet* of all *Magneticall* bodies, we shall see and behold, that not onely in the *Load-stone* the *Terrella* and *Semiterrella*, but principally in the great *Terra* and *Magneticall* globe of the Earth, there is naturally found the two poles, the North and South, the æquator, the meridians, paralels, axis, and horizon, whereupon all the motions and conclusions that haue bene made vpon the meridians of the sayd formes in the *Magnet*, are proportionably and agreeably to be found in the *Magneticall* globe of the earth, in passing about her meridians, for all *Magneticall* motions are performed vpon the meridians principally, as hath bene said. Therefore place any *Magneticall* body, as is vsed to be done, free from all obstacles, *Tab. X I. Fig. 5. 6.* that may hinder their motion and conformity, and they will be situated conformably vnto the meridian of the earth, because that the earth hath primarily, naturally, & frō her first creation, all *Magneticall* faculty, vigour, vertue, power, and potency in her selfe.

And first if a *Magnet* whose poles are knowne by the Art before taught, be placed in a boate, or boule of wood, and put into a great bason or boule of water, it will conforme, direct, and seate it selfe North and South, according to the same position and meridian that passeth directly vnto the poles of the earth; Likewise take a *Magneticall* needle that hath bene excited with the Adamant, such as be in moueable dyals, or  
else

else take the Marriners compasse, and place them in quiet situation, and they will be directed by the disponent vertue and *Magneticall* vigour of the earth towards the North, and South poles vpon the true meridian circle and line, if there be no obstacle.

All direction is obserued by *Magnetical* bodies, especially by the directory-needle and compasse vpon one certaine horizon, whose center is in a meridian cut by some of the paralels, and on this center the needle and compasse is supposed to be placed, being truly peased and composed, that they may play, turne too and fro, and rest leuell and paralell vnto the horizon, fitly placed vpon a pin of brasse or siluer, and be well touched and excited, to the end they may be directed more certainly towards the poles vpon the meridian, *Tab. XII. Fig. 13.*

All *Magneticall* needles would be touched with a good vigorous and bigge *Load-stone*, that being capped listeth vp at least halfe a pound weight of iron, to the end it may carry the flie and card of the compasse more strongly to his true direction and situation; all needles and compasses that are to be animated and excited with that part of the *Magnet* that seateth it selfe North, swimming in a dish vpon the water, by the disponent power of the earth, and being freed from out of the orbe and vertue of other *Magneticall* bodies, these are turned and directed by the vigor of the earth into the South vpon the meridian line.

Euen so a rod of iron that stath bene placed North and South in a window a long time, whereby he hath receiued a true touch of polar vertue from the Earth, being within the orbe of his vigour, and being removed from this position, which would be noted with



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chalke, and hanging leuelly in a string in the aire, will moue his North part, and seate it in the South quietly.

Therefore all *Magneticall* bodies, whether it be the *Magnet* that is taken out of the Earth, or a part of a *Magnet* taken out from this stone, that was cut immediately out of the earth, or any iron or Steele that is excited, either from the earth, from an Adamant, or from another excited needle, iron, or knife, or long forme of burnt clay, all these whatsoeuer receiuing their directiue and polar faculty from another *Magneticall* body, being set at liberty artificially in the aire or water, to moue and turne, will seate and be directed to the contrary pole they were first reuiued by.

Euery part from the æquator to the pole doth giue a polar and *Magneticall* vertue vnto diuerse formes of iron and Steele to moue vnto a contrary position, by the directiue faculty of the earth.

This faculty directiue is as strong vpon the æquator as elsewhere, though it do not bestow it to others, being fortified from both prouinces on either side, and when the needle and compasse shall be in the æquator of the earth, because their libration and leuelnesse is all one with the horizon: therefore here the direction is conformable and strong: but in other places, and neere the pole especially, the leuelling of the needles is more violent, because they would incline and make an angle with the *axis*, and therefore the direction here is thought by some to be very weake: yet in this place neere the pole in the *Terrella* and *Semiterrella*, the little needle on his foote beareth himselfe most strongly and stiffely, that being with a finger turned awry, it will turne againe to his direction very violently, though inclining to the stone, and rest it selfe very



very speedily, without many turnings to and fro, so that neere the pole the direction is very strong, neither by leuelling hindred.

Alwayes and in all places the Lilly of the compasse or crosse of the directory-needle standeth and is seated into the North, both in this North side, and on the other South side of the æquinoctiall line or circle of the earth, *Tab. III. Fig. 9. Tab. XII. Fig. 13.* contrary to the fyte of the needle neere the *Terrella* or *Semiterrella*, because they are touched and excited at that point of the *Load-stone* that in his boate resteth South, and being set at liberty from the *Loadstone* by the earth is turned North, as the point touched at the North-pole of the Adamant is turned South, neither needeth there here any conuersion of the compasses in sailing and going from one prouince of the æquator to the other, as the needles doth towards the *Magnet* being masculine, and the needles of iron or Steele feminine, but the needles to the earth are perfect *Magneticall* bodies, and do keepe their correpdency with the earth, as if they were *Magnet-stones*, or diameters of little earthes: therefore the needles and compasses passing from one side of the æquator to the other, in a meridian and great circle, proceedeth on still in a right line vniformely, onely the points of the needles and compasses do take their turnes to be predominant in their direction in their owne prouinces, especially if their leuel would suffer the vertue *Inclinary* to preuaile, which thing is most apparant by the *Inclinary-needle* in his ring, that being on this side of the æquator erecteth his lilly aboue the horizon towards the pole, but on the further South side of the æquator dipperth his Lilly vnder the horizon, and suffereth the point

point to respect his owne pole with conuenient angles to the *axis*. But this thing cannot be done by the compasse and directory-needle, which lye alwaies parallel to the horizon, but onely is demonstrable by the stone in the 4 and 5 tables before.

This were a fit place, to speake of the order of making Sea-Compasses, the instruments for *Magneticall* direction, the making whereof is very well knowne vnto Artificers, yet I could wish, that they were more artificially made then they are, though the price were some-what more, with some additions, which wee do partly touch in the Chapter following, and wish also that the points were 48. in vse, that euery point might be halfe an hower.

All direction is performed vpon the true Meridian respecting directly with the Needle the poles of the earth, as the Needle doth in the good and pollished *Load-stone* and *Terrella*, vnlesse it be weakened, depraued, and forced to decline from the true Meridian of the earth, by the causes of variation.

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## CHAP. XXVI.

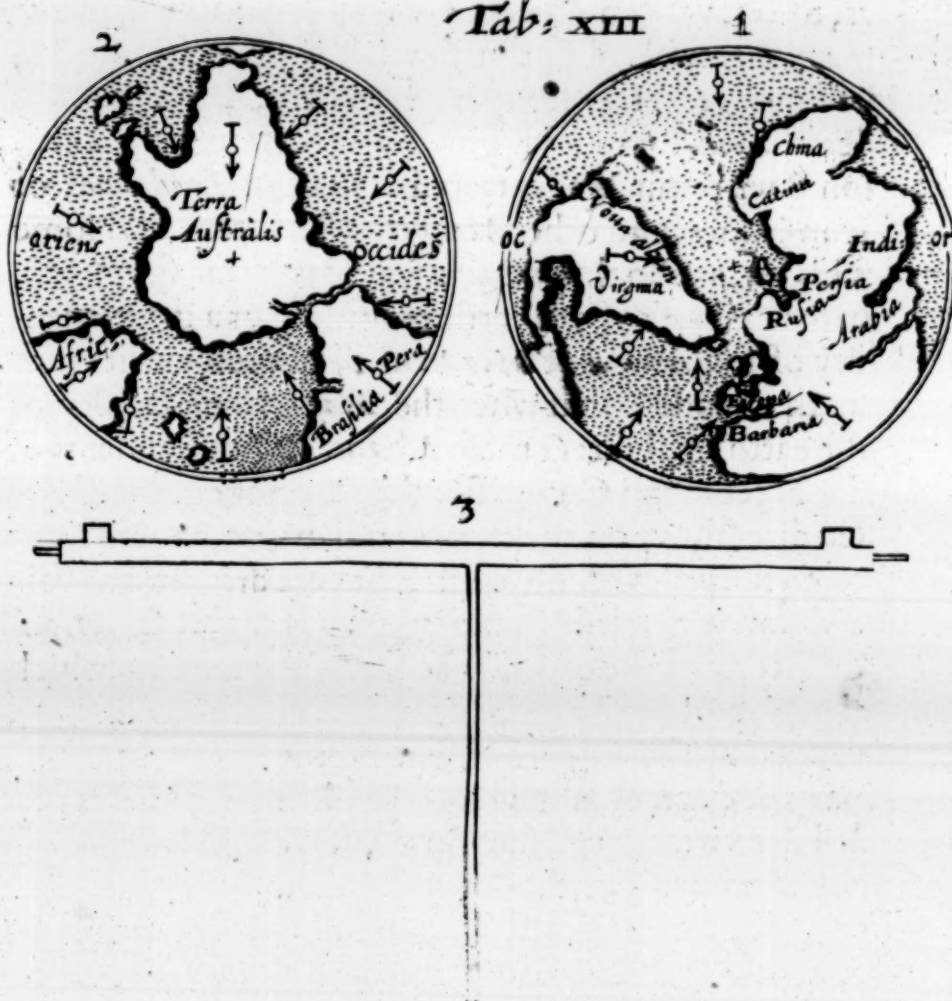
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### *Of the variation of the Compasse from the true Meridian.*



The body of the *Magneticall* Globe of the Earth, is the author and cause of all direction, and true motion to the North and South vpon the Meridian, the which would alwaies be certainly pointed out by the directory-needle and

Tab: XIII



and Compasse, if the substance of the globe of the earth were in all parts and places alike, and equally *Magnetical*, as in some round *Loadstones*; neither would there be any variation & declination of the compasse and Needle at all, from the true Meridian of the earth, no more then there is of the Needle, vpon a firme polished and round *Load-stone*.

O

But

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But because the Globe of the earth is knowne vnto vs, to bee very vn-euen and vn-equally mixed, with many materials, differing from *Magneticall* substance, hauing great and stony Mountaines, large Vallies, deepe Seas, long and high Continents and fore-lands, some with mighty scattered rockes of *Loadstone*, of Iron-Mines, and other *Magneticall* matter, and some without, as also the entrailes, and interiour substance, barke or scarfe of the earth, consisting of a great quantity of substance not *Magneticall*, whereupon it cometh to passe, that when the *Magneticall* faculty of the earth shall direct these *Magneticall* instruments of the Needle and Compasse, they are not composed or set directly vpon the true Meridian that passeth right on to the poles of the earth, but are drawne and forced awry towards some vigorous and *Magneticall* eminency of the earth, whereby the Meridian which the Needle and Compasse maketh doth decline and vary from the true Meridian of the earth, certaine parts & degrees in the Horizontal circle, which is called the variation of the Compasse; the Meridian that this declinatiō of the compasse & needle maketh, may be termed the *Magneticall* Meridian, to distinguish it from the true Meridian, and the space betweene the *Magneticall* Meridian, and the true Meridian is the difference of variation; So that here the needle & Compasse do dispose themselues into the North and South obliquely, and not truely and exactly, and according to the diuersity and strength of the scattered *Magneticall* bodies, being the causes of variation, the arch of the declination is greater and lesser, as in sayling by great Continents, and High-lands *Magneticall*, either the point or taile of the Needle, and Compasse, is forced



ced awry towards the East or West, as is demonstrated in the chapter of Applications, & in the XXIII. Chapter.

For if the *Magneticall* eminency, whether it bee iron like clay, myne of iron, or rocke of *Load-stone*, be contiguous vnto the *Magneticall* Globe of the earth and fastened in the same substance vnto it, then the Compasse and Needle will leaue the direction of the *Magneticall* Globe of the earth, and deflect towards this eminency, but if this Mountaine *Magneticall* be not continued with the Globe, and haue other Materials vnder and about him, then the Needle and Compasse will be thrust awry, and flye from it, declining as much, in a maner, the other way, leaning vnto it by the other point or taile, as it is demonstrated in the rule of Application of one Needle, in his varrying vpon the *Load-stone*, vnto a peece of Iron, touching and not touching the stone.

And no lesse doth the Needle and Compasse vpon the continent and inner-land, decline Easterly or Westerly, when as a great part of the earth shall bee of a substance no way *Magneticall*, and the other part shall bee of a vigorous and Adamantine quality to attract vnto it.

For although all direction to the North and South by the Needle and Compasse, be from the vertue of the whole *Magneticall* Globe of the earth, yet a strong effectuall, and neere perticular cause, though weaker, as it is proued in the end of the XXIII. Chapter, varieth their direction diuersly, and erratically, by that Land especially which lyeth and treateth North and South.

Where as the vigor and potency *Magneticall* increaseth

creaseth from the Equinoctiall to the poles of the *Magneticall* Globe of the earth, as it doth in the *Terrella*, whereby the like eminency *Magneticall*, in the parts neere the poles, be of more allicient and Adamantine property, then they are about the Equinoctiall, therefore it may bee thought, that in sayling vpon one Meridian, in like distance, from this eminency, enriched with this vigour, it will make a greater variation of the Compass neere the pole, then it doth neere the Equinoctiall, but this matter may bee helped and lessened by the great vigour that the needle is directed withall from the Adamantine Globe of the earth, especially if the Seas bee shallow, and the Needle in a neere Orbe vnto the same, for thus the Needle will very hardly bee remoued, because the force of the earth is great that directeth it, but marke that in the XXII. chapter, where a smaller strength *Magneticall* altereth quickly the retention of the whole more vigorous *Magnet*.

Also it is thought, that the variation of the compass is much furthered by the naturall inclination of the needle and his conformity to an high-land, along the Meridian, betweene the æquator and the pole, like the demonstration of the *Tab. VII. Fig. 2.* where the long *Load-stone* varieth the Needle from the Meridian by little and little to a right angle, so if it could bee found out, that a neere perticular cause were so potent to vary the needle, as the long-stone, there is the side of the land would vary much, but the cap farre more, also at the æquator, as in the *Tab. VIII. Fi. 5.* an eminent part of land, ending at the æquator, might vary the needle much, as is there demonstrated.

Although these applications be great inducements  
that

that there should be such positions of the Compasse, in some places betweene vigorous lands, to be obserued, yet because that these eminences from land, are not any particular and complete *Magnets* of themselves, but adherences and protuberances of some part of the *Magneticall* Globe, and haue their nature according to the vigour of that paralell where they stand, and haue not euery one of them a pole neere their caps and angles, as these *Magnets* haue, in their demonstrations set downe. I cannot wholly approue them for sufficient demonstrations of variation, though they may helpe very much for the vnderstanding of the same.

Therefore, for the better knowledge of the variation of the Compasse by the *Terrella*, it is very conuenient to apply a strong *Magneticall* body vpon the *Terrella*, alongst the Meridian, or a little obliquely, then carrying a little needle vpon the *Terrella*, the needle will vary more from the true meridian neere the æquator, then it will doe neere the pole, because the Needle neere the pole is directed very strongly and stiffely by those parts, and will hardly bee forced from his direction.

But let the eminency bee very vigorous thicke, and about twenty degrees high, then hold the Needle so high from the *Terrella* in that Orbe, then the Needle is to be conueyed from the æquator to the pole, and first bring this eminence towards the Needle, and it will beginne to vary from his direction, being within twenty degrees or parts of the eminency, and so increase his declination continually till hee bee varied towards sixty degrees, in the parts neere the æquator, and about fifty degrees, at the most, in the parts neerer



the pole in the same Orbe, therefore the deeper that the Seas are, the greater is the *Magneticall* Orbe, and the more subiect to suffer the Needle to bee attracted by a neere eminency, and the shallower that the Sea is, the lesse is the *Magneticall* orbe of the earth, which more hardly suffereth the Compasse to vary.

This is to bee noted that high-eminences and lands neere the poles, being before the Compasse doe not cause the same to decline, but onely such eminences as are placed according to the Meridians, and trent North and South, or obliquely a little on either side, to these the Compasse will be attracted awry from his true direction.

But if there be a narrow passage betweene two high-lands, then the Compasse and Needle will respect neither eminency, but carry and direct it selfe paralelly betweene them both, when the strength of two high-lands is of equall force; as it is demonstrated vpon the *Terrella*, and not vnlike to the figure, *Tab. VIII. Fig. 3.*

This is to be obserued also, that the middest of an high-land, by demonstration vpon the *Terrella*, doth attract most, and make the greatest variation, and towards the ends it decreaseth by little and little, and once passing by the enainency it varieth the compasse no more, and it is likely so to do vpon the earth.

If there be a *Magneticall* rocke lying fidelings vnder the water, it will make the needle vary a little from the true Meridian.

Therefore the farther that the Compasse is distant from an high-land, that attracteth, the lesse is the variation, and passing further out of the orbe of his vertue there will be no variation at all, vnlesse the deepes and substance of the earth bee partly *Magneticall*, and partly



partly of different substance, For these causes it is observed, that places of a small distance asunder do differ much in their variation, holding one proportion, neither in passing vpon a meridian, or on a paralell, yet in one and the selfe-same place variations neuer differ, but remaine certaine and constant.

The West-shore of a *magneticall* continent doth make the variation of the compasse Easterly, and the East-shore of a maine-land beholding the Sunne rising attracteth on the North-side of the æquator, the Lilly of the Compasse that it decline West from the true Meridian, on the South-side of the Equinoctiall the point of the Needle is attracted, *Table XIII.*  
*Fig. 1.2.*

About the Ilands of *Azores* the Compasse hath little variation, as at *Fayall* the Compasse varieth to the East three degrees, and at *Coruo* the variation of the Compasse four degrees to the West.

Some thinke that Ilands, though *Magneticall*, make no variation, being too weake and feeble in regard of the great strength of the directiue globe of the earth, which directeth the needle and compasse, because that the Iland of *Elba*, neere *Florence*, being ful of *Load-stones*, causeth no variation of the compasse more then other places neere adioyning do, but if vpon the *Terrella*, as in the XXII. chapter there be neuer so little wiers applied neere a needle, it will deflect towards them, so that here perfect obseruation may be desired, which by the common rules is long and tedious to performe: therefore I will set downe ready and easie wayes to obserue the true meridian by the Sunne, that the variation of the compasse may be plainly perceiued, and that in a moment, by one obseruation only,  
to

to the end that industrious and skilfull pilots will in time furnish themselves and the world with the true obseruation of variations in all parts of the world.

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CHAP. XXVII.

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*Of finding the variation of the Compasse  
by one obseruation.*



Or this purpose there are certaine things to be knowne, and obseruations to be had in a readinesse before this conclusion be found out, first the place is to be set downe by name or note, where this obseruation is made; then the altitude of the pole in that place is to be knowne and set downe, after the day of the moneth; and the declination of the Sunne are to be set downe, all these things skilfull pylots know very well to performe. Then hauing a good sea-compasse for the water, and a large directory-needle for the land, it is necessary vpon the outmost part and circle of these to haue a limbe or verge a quarter of an inch broad for the horizontall circle, and to haue the one halfe of it deuided into two ninties of degrees, with his conuenient parts and figures, as is vsuall in all quadrants, beginning the numbers from the meridian-line, and ending them at East and West.

Next prouide a diamiter somewhat longer, then that of the circle, of brasse, wier, or siluer, hauing in the middest or center of it a small wier of the same mettall

mettall, fastened and soudred vnto it at right angles, as a *Semidiameter*, all this being framed will be like in fashion to the beame and tongue of the ballance of a paire of scales, *Tab. XIII. Fig. 3.* and iust at the East and West put this diameter through two holes of the sides of the compasse, or fasten it there with two loopes of brasse, that you may turne the semidiameter vp and downe iust ouer the center of the compasse and needle, and this may be set vpright at either end, with two little shoulders of brasse to keepe the semidiameter vpright aud perpendicular vnto the horizon.

Hauiug the compasse and needle thus furnished, place the needle and Lilly of the compasse iust against the beginning of the diuisions, then set the compasse before the Sunne, with this semidiameter erected where the compasse and needle standing in their *Magneticall* meridian, the shadow of the Sunne from this semidiameter will shew vpon the degrees of the limbe the *Magneticall* position, and azimuth of the Sunne, which is presently to be noted downe, as it is East or West.

Note that at sea if the ship turne any thing about, the boxe of the compasse must also be turned, that the meridian of the flie may be alwaies against the beginning of the diuisions.

Likewise, because of the ships vnsteadinesse at sea, it is fit to haue a wier erected from the center of the flie, whose shadow among the diuisions, vpon the flie of the compasse, will shew the *Magneticall* azimuth.

Then instantly hauiug a *Jacobs* staffe at sea, and a quadrant at land, take the altitude of the Sunne, which is to be noted downe, and after at pleasure and leysure, hauiug these petitions, the variation of the compasse



for that place may thus be had.

Take M. *Blagranes* Mathematicall Iewell, or the *Astrolabium Catholicum*, set out first by *Gemma Frigius*, which is not so ready as this, because it lacketh the rete which this hath; place the horizon of the rete to the altitude of the pole for that place, and looke where the Sunnes altitude that was obserued and almicantareth crosseth and meeteth with the paralel of the Suns declination for that day before set downe, and the azimuth or verticall circle that crosseth these two in that point where they touch, and this is the true azimuth of the Sunne from the true meridian, which differing from the *Magneticall* azimuth at first obserued vpon the compasse, the difference of these two azimuths is the arch of the variation of the compasse, and of the *Magneticall* meridian from the true meridian, which is to be set downe, that this is the variation of the compasse towards the East or West for that place.

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### CHAP. XXVIII.

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*Of finding the variation of the Compasse,  
by the circles of the Astrolabe.*

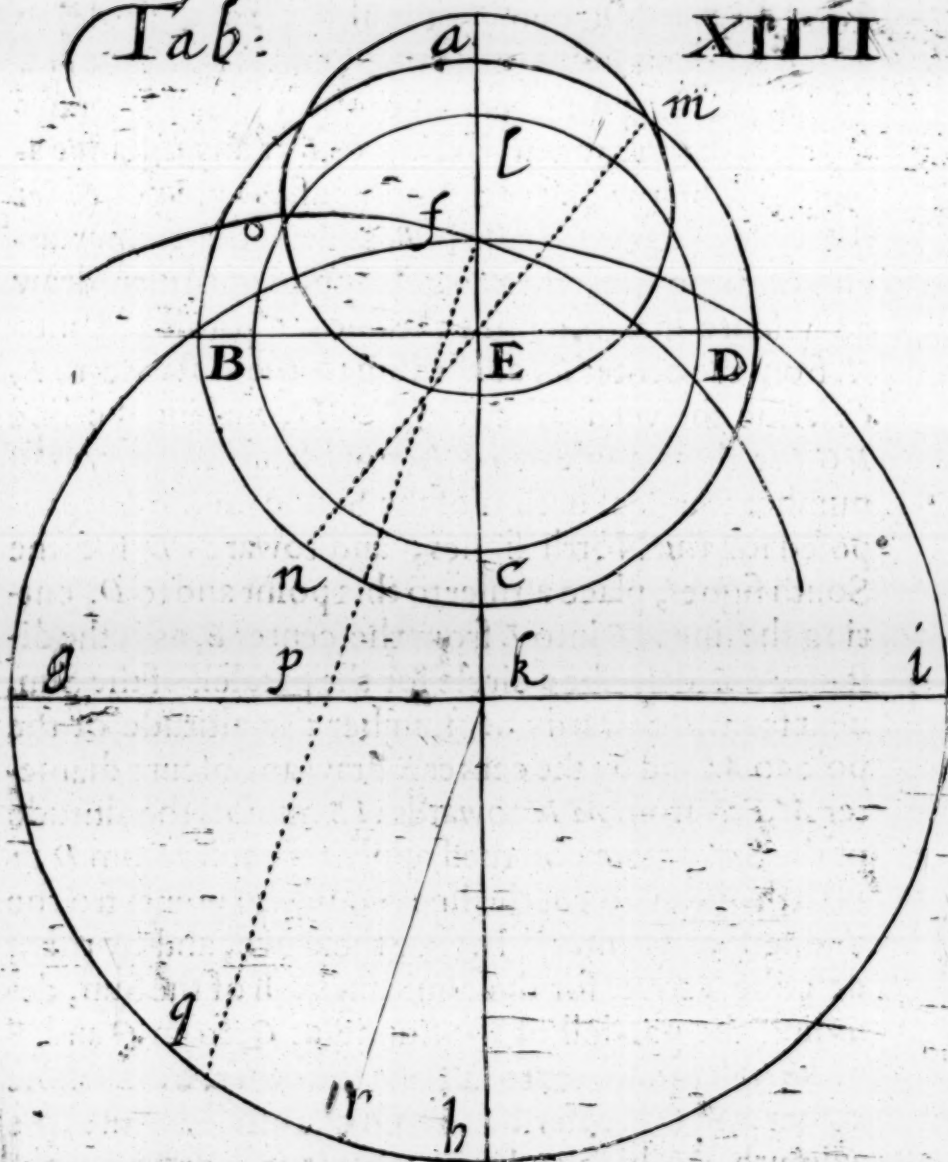


For this purpose the petitions required in the former chapter, are to be writ down, and in a readinesse, as the place of the obseruation, with the altitude of the pole in that place, the day of the moneth, with the declination of the Sunne for that day, the  
*Magneti-*



Tab:

XIII



Magneticall azimuth, and the altitude of the Sun for that one instant of observation. Now in describing the circles of the Astrolabe for this purpose, first vpon a

P 2

line

line  $BED$  at the center  $E$  make a circle  $BCD$ , and by the center  $E$  draw the line  $AC$  at right angles to  $BD$  from  $A$  towards  $B$ , number the altitude of the pole, to which point apply a ruler from  $D$ , cutting the line  $AC$  into the zenith point  $F$ , set one foote of the compasses in  $F$ , and describe an arch towards  $B$  at any distance above and below, after the compasses vnremoued set the foote of the compasse in  $B$ , and cut the former arches into points, vnto which applying a ruler, draw an obscure line to deuide the line  $AC$  produced into  $K$ , from the center  $K$ , according to the distance to  $F$ , describe the verticall circle  $FGHI$ , making the line  $KGI$  at right angles to  $FH$ , now from  $A$  towards  $B$  number the declination of the Sunne for the day proposed for the North signes, and towards  $D$  for the South signes, place a ruler to this point and to  $D$ , cutting the line  $AE$  into  $L$  from the center  $E$ , as is the distance  $EL$ , describe a circle for the paralell of the Sun, next from  $D$  towards  $A$ , number the altitude of the pole to  $M$  and by the center  $E$  draw an obscure diameter  $MEN$  from  $MN$  towards  $AB$  number the altitude of the Sun before obserued, applying a ruler from  $D$  to each deuision, to cut the line  $AC$  in two points frō the middest, as a center betweene these two, and by them describe a circle for the almicantarath of the Sun, deuiding the paralell of the Sunne at  $Q$ , from  $O$  and  $F$  make obscure arches to cut one the other, from whose center  $P$  to  $OF$ , describe an arch of a circle for the true azimuth. Which to know what it is, draw an obscure line from  $F$  by  $P$ , to the circle  $FGHI$  vnto  $q$ , then deuide the arch  $qb$  in the middest at  $r$ , and the arch  $qr$  resolued into degrees, shall be the distance of the true azimuth from the meridian. The difference

of the *Magneticall* azimuth from this azimuth, sheweth the distance of the meridian of the compasse from the true meridian, which distance is the variation of the compasse for the place obserued.

A short way vpon land to draw the meridian line vpon a plaine superficies leuelled to the horizon; immediatly before the obseruing of the altitude of the Sun, hold a plummet by a thred, that the shadow light on this superficies, in this shadow make two prickes to be ioyned together in a straight line, after out of this type set the angle  $gkr$ , which shall be the meridian from the line of the azimuth made by the shadow.

CHAP. XXIX.

*Of finding the variation by the Analemma.*



Being furnished with the petitions, before recited in the former chapters, make this Analemma, about the horizontal line  $AEC$ , describe a meridian circle, and make the verticall diameter  $BD$  by  $E$ , at right angles to  $AC$ , then from  $A$  to  $F$  in the quadrant  $AB$ , number the complement of the altitude of the pole, and by  $E$  draw a line  $FG$  for the intersection of the æquator & meridian, the number from this æquator on both sides the declination of the Sun for the day of obseruing, being 10 degrees, and from the points draw the line  $HI$  for the paralell of the Sunne, next in either quadrant aboue the line  $AC$ , number the altitude of the Sunne before obserued to be 30, to  $k$  and  $l$  ioyne these two  
P 3 together





together in a line paralell to *AC* the horizon, passing through the center of the Sunne, and cutting the verticall line *BD* into *M*, and the paralell of the declination of the Sunne *HI* into *N* from *M* a center, describe a semicircle to *kl*, and from *n* draw a perpendicular line with *kl* vnto this semicircle, deuiding the same in *O*, and ioine *mO* by a line together for the distance of the azimuth from the true meridian, which being resolued into degrees, and compared with the *Magneticall* azimuth, the difference betweene these azimuths sheweth the degrees of the variation of the compasse.

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CHAP. XXX.

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*Of finding the variation of the Compasse  
by an Equinoctiall Diall.*



**P**rouide in a readinesse, an vniuersall Equinoctiall Dyall vpon a plaine, that may artificially be erected to the height of the complement of the Latitude of the pole, for the place of obseruation, and vpon the center of the Equinoctiall-circle place a ruler, and at eitheir end of the ruler erect a plate of brasfe, little more then a quarter of an inch broad, that may with iointes conueniently bee raised at right angles, to the ruler and superficies of the Dyall, and vpon these plates place the diuisions of the Trigon of the twelue signes, after this manner. *Tab. XV. Fig. 2.*

Draw

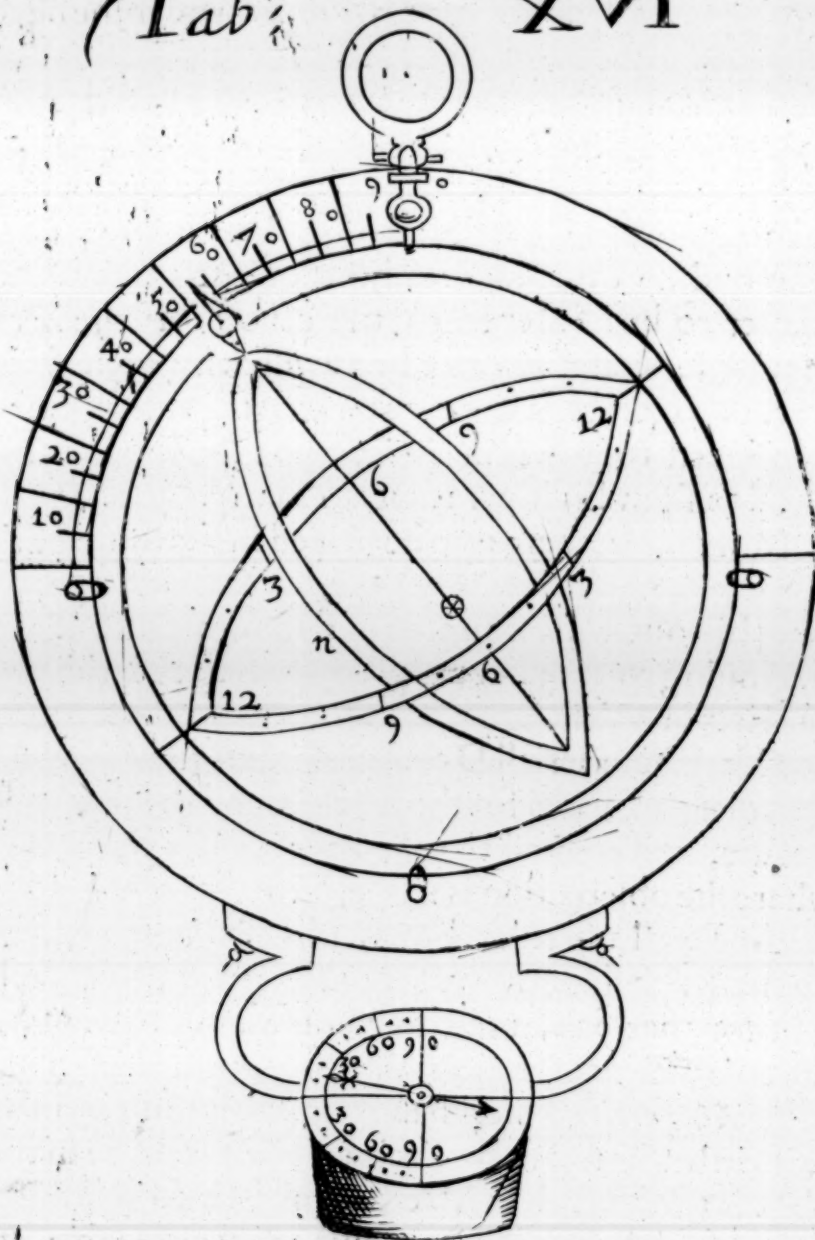
Draw a straight line  $ab$ , and from  $a$  center, describe a quadrant of a circle to  $c$ , and let  $ca$  cut  $ab$  at right angles, then deuide the quadrant  $cb$  into ninety degrees, then from  $b$  towards  $c$  number the greatest declination of the Sunne, which is 23 degrees and an halfe, ending in  $d$ , and at  $d$  draw a line at right angles, to  $ab$ , which is  $db$ , and set the length of the line  $db$  from  $a$  to  $b$  in the line  $ac$ , then produce the line  $ab$ , obscurely to  $e$ , and from  $b$  as a center according vnto the distance  $bd$ , make an obscure semicircle ouer the line  $abe$ , deuide this semicircle into fixe parts, for fixe signes, euery diuision containing 30 degrees, when it shall bee sub-deuided then ioyn these diuisions together in paralell lines to  $abe$ , for the beginning of the fixe South-signes, then from  $db$  draw a paralell line  $fg$ , according to the bredth of the plate, and from  $d$  to  $f$  make a paralell to  $abe$  in  $df$ , the plate being some-what higher, make an hole, as in a Dioptr, that the Sunne may shine in at it in Summer time, vpon the other plate at  $ab$  for the North-signes, which plate  $abik$ , would bee of the same bredth and height that  $bd, fg$  is, then let the obscure paralell lines of the beginning of the South signes bee drawne vpon this plate, place  $\text{♎}$  *Libra* aboue the line  $bg$ ,  $\text{♏}$  *Scorpio* aboue next line,  $\text{♐}$  *Sagitary* aboue the next line, and vnder the line  $df$  place  $\text{♑}$  *Capricornus*, vnder the next  $\text{♒}$  *Aquarius*, and vnder the next  $\text{♓}$  *Piscis*, the other plate for the North-signes, must haue the same paralell lines in it that this hath, for the beginning of the North-signes, and an hole in it for the Dioptr, that the Sunne may passe through it to the first plate of the winter-signes to shew them that part of the plate or end that hath the Dioptr in it is to bee placed in the

the line *b a k*, contrary to the situation of the paralels in the first plate, & vnder the vpper-most line *h i*, place *V Aries*, vnder the next *♋ Taurus*, vnder the next *♊ Gemini*, then aboue that line that hath the Dioptr, in it place *♋ Cancer*, aboue the next *♌ Leo*, and aboue the next *♍ Virgo*, so is all the characters of the signes placed in their plates, let the ruler be of the bredth of the plates, and in the middest of it draw a line, and in the middle of it make a hole of the center *L*, the better to bee fastened to the center of the Equinoctiall: *k* and *m* must bee artificially ioyned with ioyns together and *g n*, at which the ruler from *l* is produced to make an *Index* vpon the Equinoctiall-dyall to shew his howre as it is *Tab. XV. Fig. 2.*

More-ouer, there is to be placed in the foote of this Equinoctiall Dyall, a large directory-needle, hauing his outer-most circle diuided into fourè ninties, beginning to number the parts from the Meridian to the East or West.

This Equinoctiall Dyall being thus furnished with the ruler and plates for the Zodiake and the directory-needle, and erected to the Equinoctiall of the place, where the obseruation is made, turne the whole frame of the Dyall and ruler about with his plates, vntill the Suune-shine directly vpon the signe and parts that he is in for that day, then his whole frame will stand in the true meridian, and the directory-needle will stand in his *Magneticall* meridian, and point out so many parts in his horizontall circle, as his variation in that place is to the East or West, which is to bee noted downe, and the ruler in the Equinoctial circle sheweth the true hower and part of the Sun, for that day and instant.

*Tab* XVI





## CHAP. XXXI.

Of finding the variation of the  
Compass by Rings.

Here is an other instrument consisting of foure ringes of Brasse, one to be placed within the other, which is an vniuersall Dyall, hauing a directory-needle in a boxe, fastened at the bottom of the same, which doth shew likewise presently the variation of the compass hanging perpendicularly, *Tab. XVI.*

The first two rings of this instrument are two meridians, the ouer-most is broad, and hath a ring to hold it by, fastening it to the vpper end or top, and the North-quadrant towards the ring or handle is diuided into ninty degrees for the numbers of the altitude of the pole, also this ring hath fastened vnto it at the bottom a directory-needle in his boxe, the limbe whereof is diuided into two ninties from the meridian to the East and West.

Within the ring of this broad meridian, there is an other meridian-ring placed, so kept in on the sides, that it may be moued higher or lower, so that his broad *Index*, fastened vnto one of the foure quadrants, may be set to point out the degrees of the altitude of the pole, this *Index* hath a lower end for to stay the fourth ring that carrieth the Trigon of the signes, and a thred like an *axis* with a moueable beade thereon.

The third ring within the second is for the Equinoctiall circle, and it is fastened to the moueable Meridian-ring at right angles to the eleuation of the pole by two pinnes, whereon it may bee moued at right angles to the meridian, though it will be laid within the said meridian, in the inner part of this ring there is a circle to bee drawne for the Equinoctiall circle, and to bee diuided into 24 parts, for the howres of the day, from the meridian, and sub-diuided with conuenient lines and figures.

The fourth ring is fitted within this Equinoctiall ring, and at fixe of the clocke, or at the East and West is fastned to it with two pinnes, to moue at right angles vnto the same, this carrieth an *axis* which being moued about is stayed by the nether end of the moueable meridians *index*, descending into a nicke in it to hold it at right angles with the æquinoctiall-circle in manner of a sphere, and holdeth the said circle at right angles with the meridian, within this fourth ring, whose *axis* is stayed by the *index* from either side of the æquinoctiall, hauing the center in the æquinoctiall at the side of the ring, there is described aboue it, and below it, the greatest declination of the Sunne, and the arch betweene the same and the æquinoctiall is diuided into such parts for the beginning of the twelue signes as the plates before were in the former chapter, adding the characters of the twelue signes, as it was there done; then at the sides of this ring in the æquinoctiall where the center of the fore-said declination was taken, fasten the head of a pin of brasse, and from it beholding the signe & place on the other side that the Sun is in that day, and betweene the eye and that place in this line place the beade vpon the *axis* and so fixe it.

Now

Now hauing this instrument thus prepared, set the *Index* of the moueable meridian vnto the altitude of the pole, and mouing the Equinoctiall circle, and the colure-circle or different of the signes, and fasten it firme at the lower end of the *Index*, hold the instrument by the ring, or handle, like a sphere perpendicularly, and turne it too and fro till the shadow of the bead light vpon the middle line of the æquinoctiall-ring, thus the meridian of this instrument standeth vpon the true meridian, the shadow of the beade sheweth the howre and his part of the day, & the needle in the boxe pointeth out the variation of the compasse in the limbe of the horizontall circle.

These rings, at pleasure, may bee folded one with in the other for conueniency of cariage, and in time of vse set abroad like a sphere.

Any vniuersall, or Astronomers ring, would bee of especiall vse for the finding of the true meridian, as well as these, and hauing the needle added vnto them, the variation of the compasse would be found.

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CHAP. XXXII.

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*Of finding the variation of the Compasse  
by an Horizontall Dyall.*



Hen I was a yong student in the Vniuersity and delighted in making of Dyals, I was alwaies wont to place the lines of the twelue signes in them, that when I set any bodies of Dyals in the Sunne, vpon a leuell foot, I alwaies

waies directed them by the shadow of the Sunne vpon his signe and part into the true meridian and South, and hauing a large horizontall Dyall for any Region, with the lines of the twelue signes described in it, placing the same vpon a leuell plat-forme, and turning it vntill the nicke of the shadow of the stile light vpon the place and signe that the Sunne was in for that day, then fixing a compasse or needle with his meridan paralell to the meridian of the Dyall, the needle will shew in the limbe of the horizontall circle the variation of the compasse, and the Dyall sheweth the howre and his part of the day.

This Dyall might bee made vniuersall as well as the æquinoctiall, if that in traouelling North the North side were eleuated by meanes of a quadrant, that the plaine of the Dyall might alwaies haue the pole of the Dyall erected aboue him to that latitude for which it was described, and in passing Southerly the South-side of the Dyall would bee situated by the quadrant to his proper eleuation.

And if that the Azimuths and Almicantars were put into this Dyall, then the Azimuth and altitude of the Sunne, with the place of the Sunne and howre, would be presently shewed by the shadow of the stile, so that for these purposes, this horizontall Dyall would bee made vniuersall, as a generall Astrolabe or Astronomicall ring.



CHAP. XXXIII.

*Of finding the variation in degrees and minutes by the doctrine of Triangles.*



Hereas many may be desirous to know precisely the degree & minutes of the variation of the compasse, for to satisfie these mens appetite, it is very convenient to vnderstand the doctrine of Triangles, for by the Tables of sines, Secants, and Tangents, with the Axiomes and consequents, & the Golden rule this matter will be attained vnto. And therefore for this purpose, I would aduise you to obserue and mark the frame of the Analemma set downe before in the XXVIII. chapter, *Table XV. Fig. 1.* with the obscure lines pricked therein.

First in this Analemma let  $GC$  equall to  $AF$  bee the eleuation of the æquinoctiall line, consisting of  $38$  and an halfe, which being called to  $CL 30$ . the Sunnes altitude at the instance of obseruation for that day, and the some of these will bee  $68\frac{1}{2}$  whose Sine is the obscure pricked line  $LP$ , now take  $AK 30$ . degrees being the Sunnes altitude, out of  $AF$  the æquinoctiall Altitude  $38\frac{1}{2}$  thereresteth  $Kf 8\frac{1}{2}$ , whose sine is the obscure line pricked  $qK$ , which added to  $LP$ . produced make  $LP S, 77$ .

Diuide  $SL$  into two equall parts ending in  $t$ , and take from  $St$ , being  $38\frac{1}{2}$  the sine of the Sunnes altitude.

tude  $Kq$  8; and take also out  $hr$  being 10, the sine of the Sunnes declination, and there will remaine  $tV$  being 20, then ioyn  $t$  and  $m$  together in an obscure pricked line, and make a line at right angles to this from  $m$  to  $x$  being 20, and is equall vnto  $tV$ , so haue you this demonstration, and if you looke into the Table of sines for the numbers, you shall finde them set downe in their place.

And as the sine of  $tl$  is vnto the sine of  $lm$ , so is the sine of  $xm$  vnto the sine  $mn$ .

So that the angle  $MBK$  in the Analemma being the complement of the angle  $MBN$ , will be the Azimuth you sought for, and it is equall to the angle  $OmD$  in the said type, which compared with the *Magneticall* Azimuth, the difference betweene them sheweth what the variation is from the true meridian.

Secondly, it is to bee noted, that if this obseruation, or taking of the Sunnes altitude be before 6 a clocke in the morning, or after at night, when the Sunne is in the North paralels, that  $N$  the interfection of the Sunnes altitude and paralell of the Sunnes declination bee on the same side of the Analemma that  $t$  is on, then take  $hr$  the sine of the Suns declination out of  $lt$ , and there will rest  $tV$ , ioyn  $t$  and  $m$  together, and make a small line at right angles from  $n$  to  $x$ , equall to  $tV$ , for as  $tl$  is to  $km$ , so is  $xn$  vnto  $nm$ , &c.

Thridly, and lastly, if obseruation bee made when the Sun is in the æquinoctiall, then make the smal line  $mx$  equall to  $Pt$ , and looke what proportion  $tl$  hath vnto  $lm$ , the same hath  $xm$  to  $mn$  where  $n$  is on the æquinoctiall line, &c.

## CHAP. XXXIIII.

*Of the application of the Inclinatory-needle to the axis of the Earth.*

**W**E haue shewed how the compasse and directory-needle do apply and order themselves in the *Magneticall* meridian towards the pole, and of the correcting of his erring from the true meridian and pole, being caried leuell and paralell to the horizon, and seated in any part of the terrestriall globe, whereby, and to the end the trauel-ler by sea and land may take his course certainly, to any coast or part of the world. Now it remaineth that we treat of the vse of another needle, called the *Inclinatory-needle*, which being artificially placed in his ring, is as profitable to all Nauigators and trauel-lers, as that formerly spoken of; for by this they may know the eleuation of the pole in all parts of the world without the sight of the celestiaall globes and lights.

This *Inclinatory-needle* fitted in his ring, and placed in the *Magneticall* meridian, doth apply & conforme it selfe vnto the *axis* of the *Magneticall* globe of the Earth (whereas the directory-needle doth apply vnto the meridian and pole) and that diuersly in diuerse eleuations of the pole, for sailing vpon the æquinoctiaall of the earth, this *Inclinatory-needle* maketh a paralell-line with the *axis* of the earth, being vpon the pole, this needle will make one continued line and *axis*

R

with

with the *axis* of the earth: passing from the æquinoctiall to either pole, this *Inclinary-needle* will conforme it selfe vnto certaine acute angles with the *axis* of the earth, which increase from the æquinoctiall in largenesse, and proue lesse acute in euery paralell, so that the angle of the earths *axis*, and the *axis* of the needle is at the greatest about 42 degrees of the poles eleuation, and the difference betweene these two will be neere 22 degrees and a halfe, being here at the largest, after it decreaseth continually towards the pole, where the needle will stand directly vpon the *axis* of the earth.

Now to know and find out this angle what it is, it is necessary to learne what angle this *Inclinary-needle* maketh with the horizon in euery latitude of the pole, because if the eleuation of the pole be taken out of this angle with the horizon, which is alwayes the larger, (vnlesse it be at the æquinoctiall and the pole) and hath the *axis* of the earth alwayes betweene him and the horizon, the remainder is the angle of this needles conformity with the *axis* of the earth.

Therefore we will leaue to speake of the *Inclinary-needles* most naturall and true conformity with the *axis* of the earth, and hereafter shall deliuer by what meanes the angle betweene the *Inclinary-needle* and the horizon may be knowne, to the end that the eleuation of the pole may thereby be found out.



## CHAP. XXXV.

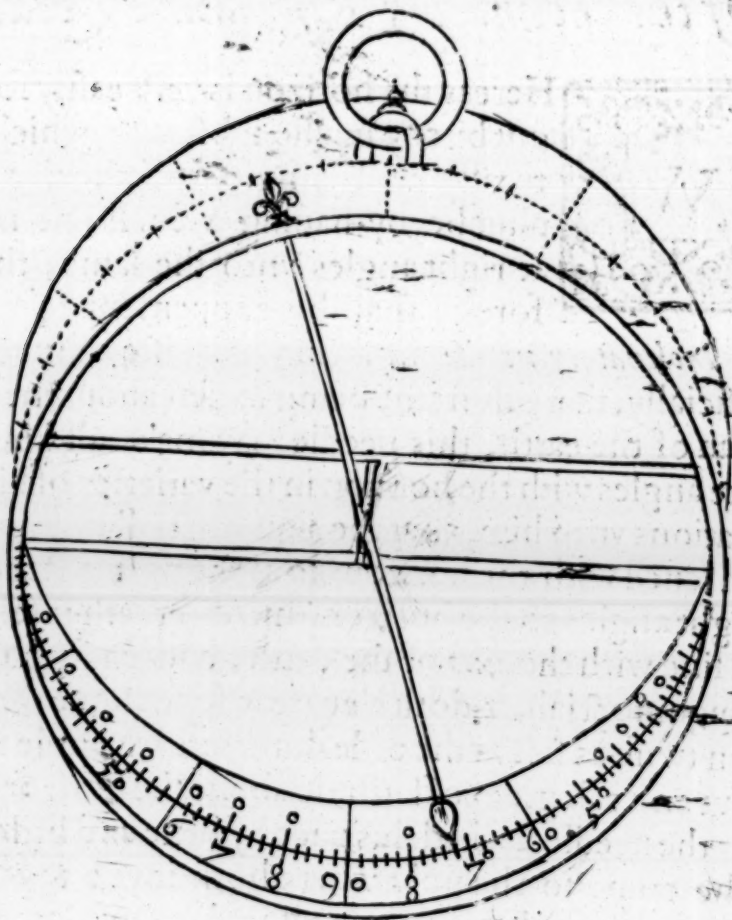
*Of the Inclinatorie Ring and Needle.*

Hereas the horizon is very easily found out by any massie substance, which naturally will hang perpendicular and plumbe, by hauing a leuell line made at right angles vnto the same, therefore it shall be conuenient to place this *Inclinatorie-needle* in a ring of brasse or siluer, so artificially, that this frame being caried about the meridian of the earth, this needle may make all kind of acute angles with the horizon in the varieties of his inclinations vnto him, as at the æquinoctiall this needle lieth leuell with the horizon, so at the pole it standeth at right angles to the horizon, and directeth it selfe in one line with the *axis* of the earth, and passing from the æquinoctiall, it doth eleuate it selfe aboue the horizon twise as fast as the pole doth, vntill the pole haue about an 11 degrees of latitude aboue the horizon, but after the needle slacketh his pace by little and little, vntill he come to the pole where both ioyne together without any angle at all in one line directly.

Also this needle maketh alwayes one kind of angle with the horizon in one paralell and altitude of the pole, and a diuerse arch from the same, but one certaine in one latitude, as by this instrument following shall appeare, and euery where be obserued.

Take a long peece of steele-wier, and through the middest and center of the same put a short wier tho-

## Tab. XVII



rough this same *axis* at right angles exactly, or rather  
 file a plate of Steele artificially into the forme of the  
*Inclinatory-needle* with his *croffe axis*, as you see in this  
 type, *Tab. XVII. Fig. 1.* and *Tab. II. Fig. 16.* and at  
 right

right angles together. Then provide a round ring of brasse or siluer, perfectly polished and rounded, of the breadth of an inch and a quarter, almost as broad as the short *axis* is in length, having a little ring, in the top to hold it perpendicularly, as in this type. This ring must have within it another plate and ring close fastened vnto it, but let it be somewhat narrower, and draw in the midst of it a middle circle for the meridian circle, which is to be deuided into foure nineties, beginning from the sides, and ending the deuisions, and their numbers in the top and at the bottome.

After provide two narrow plates of brasse or siluer, to be fastened on either side of the ring paralelly to the horizon, and in the midst of these, as it were, against the center of the ring, drill and make two little holes almost through the sides of the plates for the short *axis* of the *Inclinatorie-needle* to play and moue in, vp and downe, according vnto this kind of *Magneticall* and *Inclinatorie* conformity. Lastly, this instrument would be couered with two glasses for both sides to keepe the *Inclinatorie-needle* from wind and weather, and a care had that the instrument hang truly perpendicular.

In time of vse in traueilling, hang this instrument South and North in the *Magneticall* meridian, and this *Inclinatorie-needle* will fall with one end vnder the horizon in euery eleuation of the pole, and beare vp his other end in euery paralell and altitude of the pole to a certaine angle with the horizon, which may be called the *Inclinatorie* angle for that place, which being noted in the meridian of this ring, with the degrees he pointeth at, is to be reserued as proportionable to that eleuation of the pole where the obseruation is

made, this matter was demonstrated by the round Loadstone in every part in the XIII. chapter before, which being collected by the sayd demonstration and practise, are to be placed in their correspondency in a Table for the altitude of the pole, wherby in all places it may be had readily what will be the angle of the *Inclinatorie needle*, and what is the latitude of the pole, caused onely by the disposition of the *Magneticall globe* of the earth, and also by the diagrams following it is shewed.

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CHAP. XXXVI.

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*A Diagram of the needles inclinations to the axis of the earth, and horizon in any latitude.*

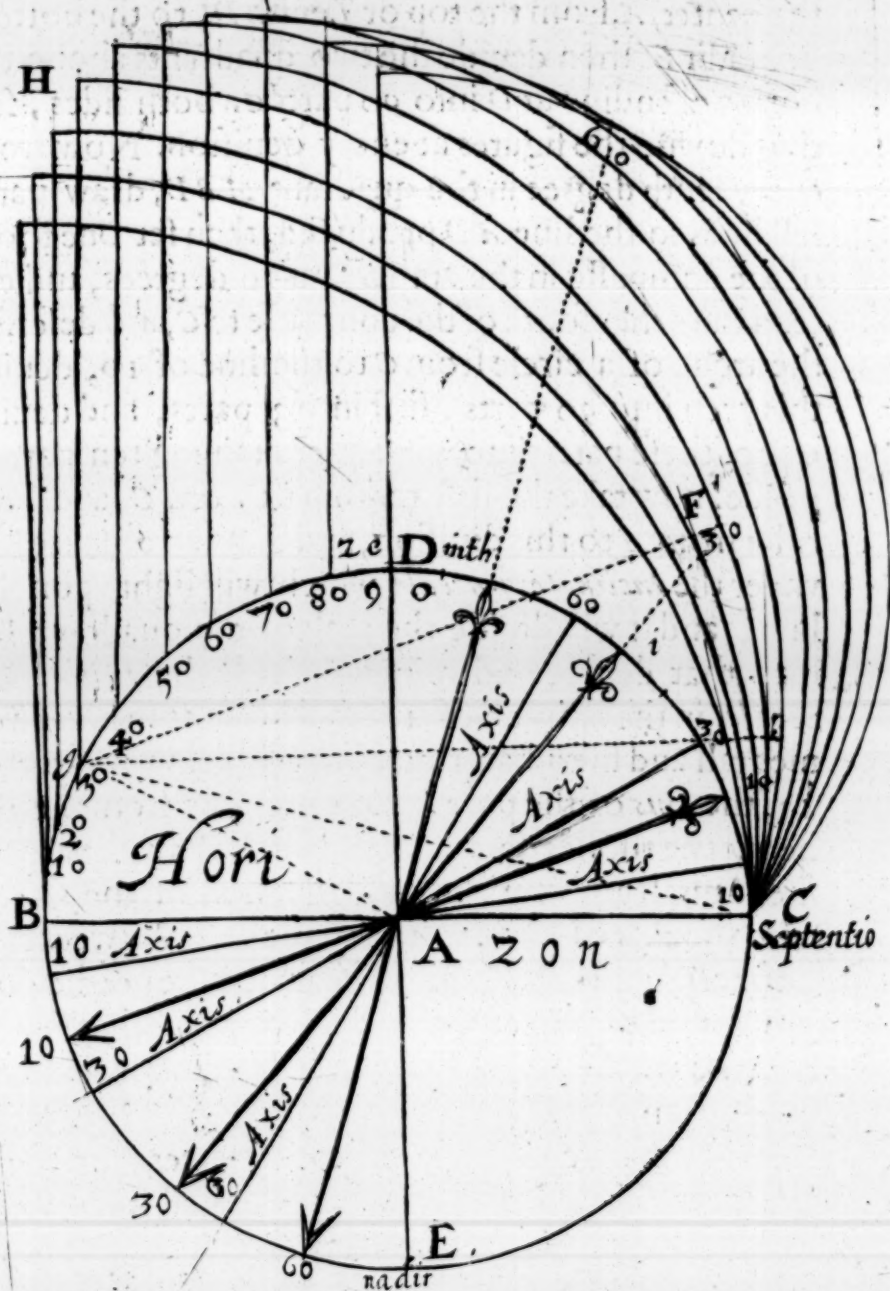


His demonstration sheweth most manifestly vnto our eyes, both what angle the *Inclinatorie needle* maketh to the axis of the world, or earth, in all regions, and also what angle or arch he pointeth at aboue or vnder from the horizon in any latitude of the pole whatsoeuer, hereby most euidently setting out the meanings of the two former chapters, and of the XIII. chapter before them, where it is demonstrated from the stone it selfe, that this *Inclinatorie needle* will make but one circumuolution about the meridian of the earth, as it doth about the Loadstone, the Diagram is this.

From the center *A* in the horizontall line *BC*, describe



(Tabl<sup>e</sup>, XVIII)



scribe a meridian circle, like that in the *Inclinatory-ring*, drawing a perpendicular line crosse the same by the center *A*, from the top or Zenith *D*, to the bottom or Nadir *E*, then deuide the two quadrants aboue the horizon, ending at *D* into 90 parts on both sides, setting downe the figures at euery deuision. Now from euery tenth degree in the quadrant *ABD*, draw paralell lines to the line *AD* produced, then set one foote of the compasse in the arch *BD* at 10 degrees, and extend the other foote of the compasse to *C*, and describe the arche of a circle from *C* to the line of 10, deuide this arch into 90 parts, first into 3 parts, and deuide one of these parts into 3 lesser, containing ten parts a peece, now take the first tenth part from *C*, and lay a ruler from *A* to this diuision, and draw an obscure line vnder the *Inclinatory-needle* which will light vpon this line, and it will diuide the arch of the quadrant *DC* into that degree and minute which the *Inclinatory-needle*, in the latitude of 10, will point at in his instrumentall and meridian-ring, which being more then 10, the *axis* of the pole, the ouer-plus from the *axis* betweene the needle and *axis*, doth shew the arch of the naturall application, or inclination of the needle vnto the *axis* of the earth, and the parts betweene the horizon to this part in the arch which the needle doth point at in the quadrant, *CD* is the angle that the *Inclinatory-needle* maketh with the horizon in the latitude of ten degrees.

In like manner from the other ten partes, or 90 degrees, in the quadrant *BD* draw paralell-lines to the line *AD* produced, and from euery part as a center extending the compasse from the same to *C*, describe arches from *C* to those lines, diuiding them into 90. parts

parts a peece, and take like number of parts answering to these parts in the quadrant  $CD$  for the *axis* of the latitude, then draw an obscure line from  $A$  to the same part, in these larger arches, and that will shew the angle that the *Inclinary-needle* maketh in his inclination to the *axis* and horizon in that latitude. We have onely for example-sake deliniated the inclination of this needle to the *axis* and horizon, in the latitudes of 10.30. and 60. the like whereof might bee performed in every one of the other degrees of latitude, which thing is omitted to auoide confusion of lines.

What this angle of the inclination of the needle would bee in euery latitude of the pole, although by the Diagramme, already set downe, it might bee Mechanically taken out of the quadrant  $CD$ , as it is reduced into ninty partes. Yet I will set downe, how out of the cannons of Triangles, the arch from  $I$  to  $C$ , may bee exactly knowne in degrees and minutes.

In the Diagram  $G, A, B$  30, the eleuation of the pole being set for an example, draw from  $G$  these obscure lines, as  $GF, GK, GC, GA$ , and  $AF$ , the line of inclination, the content of the angle  $AGC$  is 15,  $CGK$  is 15.  $KGF$  is 20, so that the angle of the Triangle  $FG$  is 18, 50, and the summe of the opposite angles, which marked vpon the semi-circle, will bee 130 degrees, whose halfe is 65 degrees, the tangent whereof is 214459690, then wee finde that the line  $GF$  in the triangle is equall to  $GC$ , the *Subtenses* of 150 degrees, the halfe or sinus hereof is 75 degrees, whose parts out of the Table of sines are 96592583, which being doubled make the side  $GF$  193185166. The side  $GA$  hath for his parts the totall sine 100000000, the summe of these two sides is 293185166, and the difference

ference of them is  $93^{\circ} 18' 51'' 66$ .

Now multiply the tangent of  $65$  degrees  $214459690$  by the difference of the sides  $93185166$ , and diuide the product  $42891938$  by the summe of the sides  $293185166$ , the quotient will bee the difference of the tangents  $146296413$ , which taken from the parts of  $65$  the middle tangent  $214459690$ , the tangent parts that remaine  $68163277$  giue by the Table  $34$  degrees  $16' 47''$ .

Here take  $34^{\circ} 16' 47''$  out of  $65$  degrees, there resteth  $30^{\circ} 43' 13''$ , for the lesse angle  $AFG$ , so adde  $34^{\circ} 16' 47''$  vnto  $65$  degrees, and it maketh  $99^{\circ} 16' 47''$ , for  $FAG$  the greater angle, heereto adde  $30$  degrees the eleuation of the pole there amounteth  $129^{\circ} 16' 47''$  for the angle  $FAB$ , which taken from the semi-circle  $180$ , there remaineth  $50^{\circ} 43' 13''$  for  $F, A, C$  the inclination of the needle vnto the horizon where the pole is eleuated  $30$  degrees.

I haue heere set downe a Table calculated out of this diagramme of the degrees and minutes of the angles of the *Inclinary-needle* with the horizon, answerable to euery eleuation of the pole, by Mr. *Brigges* the Geometry reader in *Gresham* Colledge, who hath farre more ready and easy waies to make the fore-said Table, then I haue set downe vnto thee, and I thinke that this Table will agree more truely with the motion from the stone it selfe then that which is made by the same man out of the diagramme in the Chapters following.

TABLE.



TABLE.

Ele. uat. poli	Inclinat. ad horiz. G. M.		Ele. uat. poli	Inclinat. ad horiz. G. M.		Ele. uat. poli	Inclinat. ad horiz. G. M.
1	2	2	31	51	49	61	74 58
2	4	4	32	52	54	62	75 33
3	6	6	33	53	56	63	76 7
4	8	8	34	54	56	64	76 41
5	10	10	35	55	55	65	77 15
6	12	11	36	56	52	66	77 49
7	14	13	37	57	48	67	78 25
8	16	13	38	58	42	68	78 55
9	18	12	39	59	35	69	79 27
10	20	10	40	60	26	70	80 0
11	22	5	41	61	17	71	80 32
12	23	59	42	62	6	72	81 4
13	25	50	43	62	54	73	81 35
14	27	39	44	63	40	74	82 7
15	29	25	45	64	26	75	82 38
16	31	9	46	65	11	76	83 9
17	32	50	47	65	55	77	83 39
18	34	28	48	66	38	78	84 10
19	36	4	49	67	20	79	84 40
20	37	37	50	68	2	80	85 10
21	39	7	51	68	43	81	85 40
22	40	34	52	69	23	82	86 10
23	41	59	53	70	2	83	86 39
24	43	21	54	70	41	84	87 9
25	44	40	55	71	19	85	87 38
26	45	58	56	71	57	86	88 7
27	47	12	57	72	34	87	88 35
28	48	24	58	73	11	88	89 4
29	45	35	59	73	47	89	89 32
30	50	43	60	74	22	90	90 0

## CHAP. XXXVII.

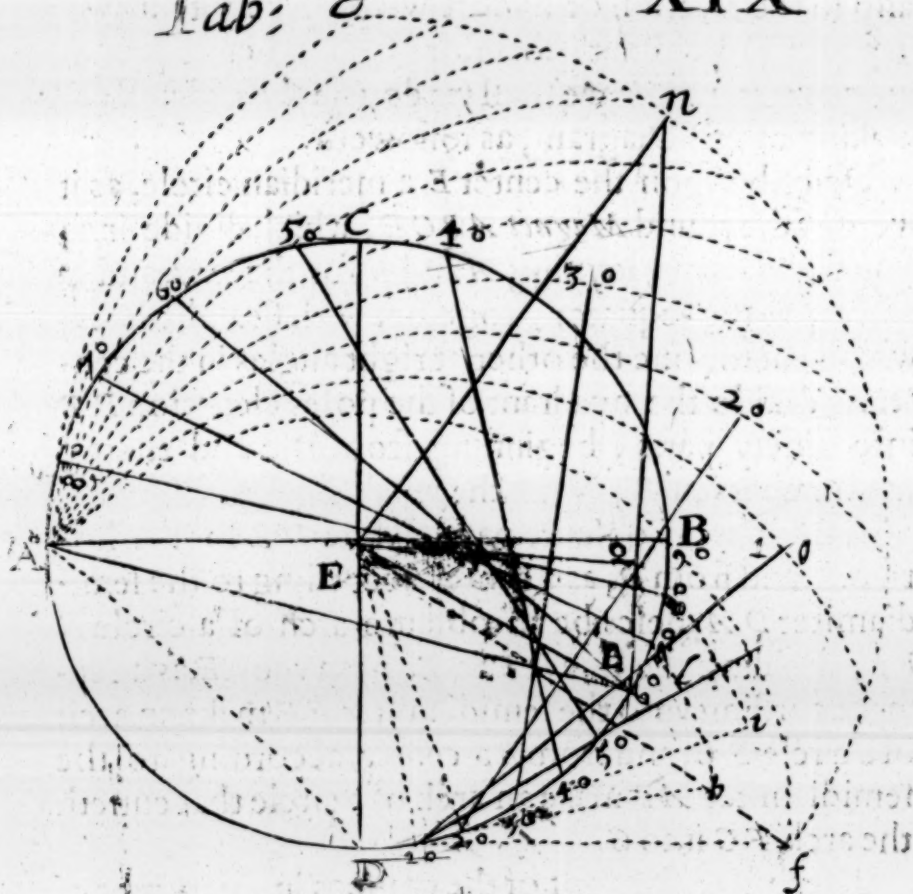
*Another Diagram of finding the angles of  
the Inclinary-needle in a-  
ny Paralell.*



Here we shall set downe another Diagram which doth properly shew the motion, conuersion, and application which the needle maketh when that he is caried about the meridian of the *Terrella* or *Semiterrella* when the poles of the same lye in the horizon, in which circumparragation this needle describeth two whole circles, as he passeth round about the meridian, as is demonstrated in the twelfth chapter before, from the stone it selfe. For this needle being placed at the æquator, it seateth it selfe paralell to the *axis* of the *Magnet*, being caried further on the quadrant toward the pole, about 17 degrees it pointeth to the pole of his orbe, and neere about 33 and 34 minutes, hauing made a quadrant in his motion, he placeth himselfe paralell to the æquator, and at right angles to the *axis* of the *Magnet*, and passing on to 45 degrees, this needle beholdeth there the æquator of his orbe, and comming to 90 degrees against the pole, it maketh one *axis* with the *axis* of the *Magnet*, and describeth another quadrant, so that from the æquator to the pole in passing along this one quadrant of the stone, this needle hath made halfe a circle, so that she should make a perrambulation round about the whole

Tab: 8

XIX



whole meridian, he would make two epicycles, like to the motions ascribed to some of the Planets.

But to make vse of this motion for the inclination, we shall onely set downe what aspects or angles the needle maketh with the *axis* of the earth at euery tenth degree from the æquator to the pole, where in this Diagram there be lines to the inside of the quadrant *DB* for the inclination of the needle, which may also be produced outward into the orbe of *Magnetick* vertue vpon the limbe, as it is set out in the twelfth

chapter, *Tab. I I I I. Fig. 2.* both in pricked lines, and also in the erection of a short wier at euery tenth degree of the quadrant: therefore for the better preferring of this matter, we shall set downe the order of the making of this Diagram, as followeth.

Describe vpon the center *E* a meridian circle, as it were of the round *Magnet ABCD*, which diuide into foure quadrants, ioyning *A* and *B* for the *axis*, and *C* and *D* for the æquator, together with straight lines, which cut the one the other at right angles in the center *E*, diuide the quadrant of the poles eleuation *DB* into ninety parts, beginning from *D*, and ending the numbers in *B*, with the vsuall figures.

At *D* draw an obscure paralell line *DF* for the horizon, and from *D*, as a center according to the semidiameter *DA*, describe an obscure arch of a circle *ABF*, diuiding the line *DF* in *F*, next vpon *E*, as a center according vnto the semidiameter *EF* make an arch of a circle *FG*, and from *B* a center, according to the semidiameter *AB* make an arch of a circle that cutteth the arch *FG* into *G*.

Then place the foot of the compas in euery part of the quadrant *DB*, as in center, extending the other foot to *A*, and describe arches to *FG*, and first place the foote of the compasse in the deuision of 10 in the quadrant, and opening the compasse to *A*, describe the arch of a circle from *A* to the arch *FG*, and diuide this arch from *H* into ninety parts, first into 3 parts, then part euery one of these into 3 parts, containing ten parts apeece, if they were sub-diuided into them, then from 10 in the quadrant, to 10 in the arch from *FG* draw a straight line 10 and 10 for the line of the inclination, now draw an obscure line from *E* to the de-



degree of 10 in the quadrant, and from this line at 10 make an obscure line at right angles for the horizon to *E* to, then take the semidiameter *DE*, and place one foote in this line from 10 to *H*; and from 10 as a center describe an obscure arch *HL* to the line 10 and 10, and this arch shall be the angle that the *Inclinatory-needle* maketh with the horizon, where the pole is eleuated ten degrees aboue the horizon, and the angle 10 *E* and 10 is the complement of the former angle.

Next place the foote of the compasse in the twentieth degree of the quadrant, and stretching it to *A* describe the arch of a circle from *A* to the arch *FG*, which being diuided into ninty parts, first into three parts, and these into three parts, againe draw a line from 20 in the quadrant to 20 from the arch *FG*, now make an obscure line from *E* to the 20 degree in the quadrant, and from this line at 20 make an obscure line for the horizon at right angles to *E*, 20, take the distance from *E* 20, and place it in the line 20 *I*, and from 20 as a center, the compasses being vnremoued, describe the arch *IM*, cutting the line 20 and 20 into *M*, which is the angle the *Inclinatory-needle* maketh with the horizon, and being set in the arch *DB*, the number of the degrees of this arch of inclination will appeare.

According to this order draw arches from *A* to *FG*, making the diuisions in the quadrant the centers, and their distance from *A* the semidiameters of them, diuiding these arches as afore is done, and drawing right lines to the correspondent diuisions in their seuerall arches from the seuerall degrees in the quadrant, whose respondent angles of inclination is knowne by making at the same and describing arches according

ding to their semidiameter from *E*, as hath bene declared in the two former examples, which being reduced into degrees, by placing the arch in the quadrant *DB*, from *D* towards *B*, will shew the quantity of the needles inclination vnto the horizon and his angle with the same.

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CHAP. XXXVIII.

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*Of finding by the Needles inclination  
vnto the horizon, the altitude of  
the Pole by an instrument.*

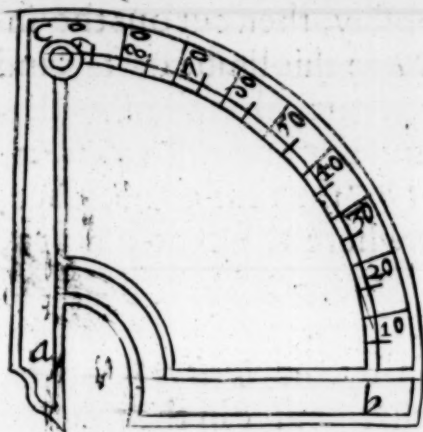
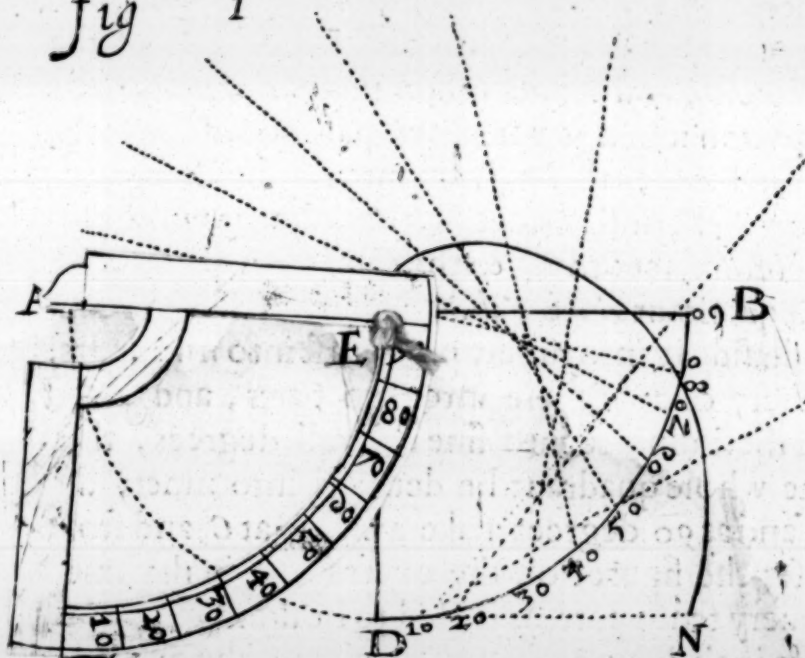


Or the performance hereof, it is necessary to haue the straight lines of the needles inclination or aspect to the *axis*, drawne in the former chapter obscurely, described againe by the former art, and the quadrant *DB* diuided into his parts. At *D* draw a parallell line to *AB*, and take the semidiameter *ED* and place it in this line to *N*, then set one foote of the compasse vnremoued on the 10 degree of the quadrant *DB*, and the other foote in the straight line of ten obscurely drawne, making a note there, then remoue the compasse, retaining the semidiameter *ED*, and place one foote in 20 in the quadrant, and the other in the line of 20, making another note or pricke there, so place this semidiameter of *ED* from 30, 40, and the rest in the quadrant on their proper lines, making notes and prickcs vpon them where they end,  
now

Tab. XX

fig

1



now ioyne these notes and prickes together with convenient lines, and there will be a spirall line described of principall vse in this instrument, *Tab. 20. Fig. 1.*

Moreouer describe a moueable quadrant of the same bignesse and semidiameter that *EDB* is of, to be moued vpon it in a paper apart, past-boord, or some mettall, whereon this instrument may be described, (the larger the instrument is, the better it will be for vse) therefore, according to the semidiameter *ED*, describe a quadrant *ABC* *Tab. XX. Fig. 2.* from *A* the center, & deuide it into ninery parts, first into nine parts, then euery one of these into two parts, and euery one of these diuided into fve seuerall degrees, thus will the whole quadrant be deuided into ninety degrees; and at 90 degrees make a center at *C*, and from *B* to *C* set the figures on the outer space in the limbe vnto euery tenth part, as is vsed to be done, after a little halfe inch distance; from the center of the quadrant *A*, describe a little limbe or stay, then cut out the inward part of the quadrant *CB* to this limbe or stay, and from the limbe to *A* cut out a part, that the semidiameter *AC* may serue for an Index or ruler, *Tab. XX. Fig. 2.* Now bring this quadrant *ABC* thus cut out, & place, and fasten the degree of 90 where the center is at *C*, vpon the center *E*, on the instrument where the spirall line is on the same, *Tab. XX. Fig. 1.*

In the time of obseruation by the *Inclinary-ring*, before described, marke what degree in the ring the *Inclinary-needle* pointeth at in the meridian circle of the same, then in this instrument here described, note the degree obserued in the ring vpon the moueable quadrant from *B* to *C*, and turne this quadrant about till that this note or degree doth touch the spirall line;  
here



here stay the moueable quadrant, & his index *C A* will shew in the quadrant *D B*, the altitude of the pole in that place.

So back-ways set the index of the moueable quadrant to any eleuation of the pole, and where the spirall line cutteth the limbe of the moueable quadrant, the degrees and parts shew what should be the number, due to the angle of the *Inclinatory-needle*, and what parts he would point out in that place. A Table of the inclination of the needle, answering to euery eleuation of the pole, might be made by this instrument.

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CHAP. XXXIX

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*Of finding the needles inclination in euery latitude by Table.*



He way to find the angle, which the *Inclinatory-needle* maketh with the horizon in any latitude, or the degrees correspondent, by a table, is most profitable and ready, because that knowing any one of these two, that is, either the altitude of the pole, or the angle of inclination to the horizon, the other is presently knowne by the table.

Seeke in this Table following the altitude of the pole in the left collumne, and in the next place towards the right hand you shall find the degrees and minutes of the needles inclination, vnto the horizon, answerable for that latitude; as for example. I would know what would be the arch of the angle of the *Inclinatory-needle* where the pole is eleuated 60 degrees, I

## TABLE.

Ele. uat. poli	Inclinatio ad horizontem.			Ele. uat. pol.	Inclinatio ad horizontem.			Ele. uat. poli	Inclinatio ad horizontem.		
	/	//			/	//			/	//	
1	2	11	15	31	52	26	38	61	79	28	51
2	4	10	13	32	53	46	55	62	80	3	56
3	6	26	55	33	54	53	1	63	80	37	54
4	8	31	23	34	56	3	56	64	81	10	47
5	10	33	41	35	57	13	21	65	81	42	36
6	12	33	50	36	58	21	19	66	82	13	23
7	14	31	53	37	59	27	50	67	82	43	9
8	16	27	52	38	60	32	59	68	83	11	56
9	18	21	50	39	61	36	46	69	83	39	45
10	20	13	47	40	62	39	0	70	84	6	37
11	22	3	45	41	63	39	56	71	84	32	30
12	23	51	46	42	64	39	29	72	84	57	24
13	25	37	52	43	65	37	41	73	85	21	2
14	27	22	4	44	66	34	31	74	85	44	24
15	29	4	23	45	67	30	0	75	86	6	31
16	30	44	53	46	68	24	10	76	86	27	44
17	32	23	34	47	69	17	2	77	86	48	5
18	34	0	27	48	70	8	38	78	87	7	36
19	35	35	35	49	70	58	59	79	87	26	18
20	37	9	0	50	71	48	7	80	87	44	9
21	38	40	42	51	72	36	0	81	88	1	10
22	40	10	41	52	73	22	38	82	88	17	23
23	41	38	58	53	74	8	2	83	88	32	49
24	43	5	37	54	74	52	11	84	88	47	29
25	44	30	26	55	75	35	6	85	89	1	22
26	45	53	43	56	76	16	51	86	89	14	30
27	47	15	25	57	76	57	18	87	89	26	54
28	48	35	33	58	77	36	59	88	89	38	37
29	49	54	8	59	78	15	23	89	89	49	39
30	51	11	9	60	78	52	41	90	90	0	0

seeke this 60 degrees in the left columnne of the table, and there I find answering thereto 78 deg. 52', and 41'', the arch that the *Inclinary-needle* maketh with the horizon, where the pole is eleuated 60 degrees.

The manner to calculate this table by the doctrine of triangles, is to obserue the proportion that is vsed in making the Diagram set downe. *Tab. XIX. Fi. I.* as let our example of 60 degrees for the altitude of the pole be numbred in the quadrant *DB* in the *XIX.* Table from *D* to *R* the arch *ADR* being 150 degrees, the angle *ERA* will be 30 degrees. The semidiameter *ER* being 10000 *RN* equall to *AR*, the cord subtending the arch *ADR* will be 19318, and *EN* equall to *EF* 17305, being the secant of the angle *DEF*, whose tangent *DF* 14142 is equall to the cord *AD*, subtending 90 degrees, these three sides of this triangle *ER*, *RN*, *EN*, being giuen, the angle *ERN* is thus knowne.

As the base thereof *RN* 19318 is vnto the summe of the sides *RE* and *EN* being 27305, so *NO* the segment of the side 7305 is vnto *NP* the segment of the base 10325, which being taken from *RN* 19318, the remainder *PR* 8993, whose halfe *RQ* 4496½ is the sinus of the angle *REQ*, consisting of 26 deg. and 43', whose complement being 63 deg. and 17', is the angle *ERN*, which we desire to know.

Ioyne this angle *ERN*, being 60 deg. 17' vnto the angle *ERA*, being 15 degrees, both which make the whole angle *ARN* to consist of 78 deg. and 17' contained within his arch *ASN*.

Because that the angle *RED* consisteth of 60 deg. therefore for answerable hereunto, take 60 degrees of this arch *NSA* deuided into 90 degrees, which ioyned



to *R* make the angle *S R N* to consist of 52 degrees and 12', which being subducted from the angle of *E R N*, containing 63 deg. and 17', the angle *S R E* will retaine onely 11 degrees and 5', whose complement *S R T* consisteth of 78 deg. and 55', declaring the inclination of the *Magneticall* needle vnto the horizon *R T*, where the latitude of the place is 60 degrees.

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CHAP. XXXX.

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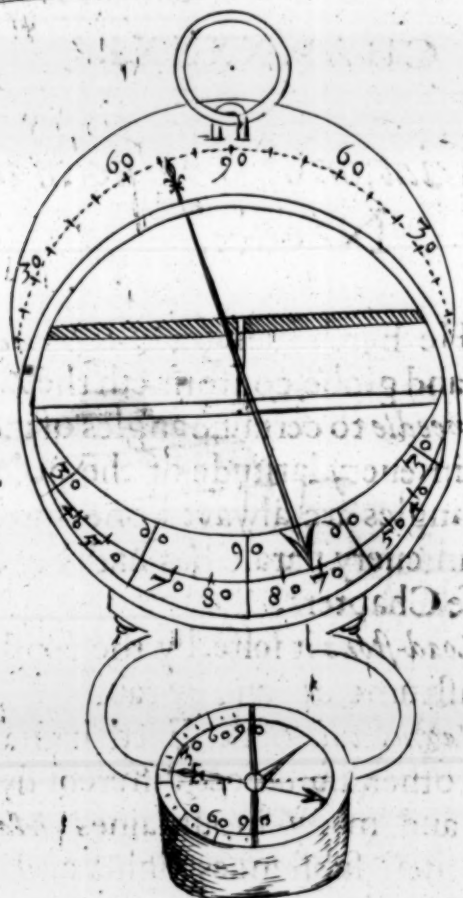
*Of finding the angle of Inclination, the  
Magneticall meridian, and the  
Azimuth together.*



**I**T is very conuenient at sea to haue a large *Inclinary-ring* with his *Magneticall needle* of a foote diamiter, that the diuisions of the meridian circle being large, the degree of the mouing needle will the better be perceiued, and to haue a waight of diuerse pounds fastned at the bottome to hold this ring plumbe and steady: moreouer on this waight I would haue a compasse, or directory-needle placed in his bottome, and a beame for a diamiter and semidiamiter of brasce, before described, for the obseruing of the *Magneticall* azimuth, as was appointed in finding the variation of the Compasse.

These two *Magneticall* needles, the one in the *Inclinary-ring*, the other in the cauitie of the bottome, being placed fise or fixe inches asunder, will not hinder





der or attract the one the other, being out of the vigor in this distance of their *Magneticall* orbes.

A long wier that hath bene excited *Magneticalliy*, being thrust through a corke, and placed in the water, will shew the Inclination and *Magneticall* meridian, at one instant, in his quiet situation.

*Of the variation of the Inclinary-Needle.*



He Earth being a *Magneticall* body and globe, conformeth the *Inclinary-needle* to certaine angles of inclination in euery latitude of the pole, which angles are alwayes one and the same in euery paralell, as hath bene demonstrated in diuerse Chapters.

Both by the *Load-stone* it selfe, by the fundamentall hypothesis, by instruments, and by tables; but because that the globe *Magneticall* of the Earth hath many cauieties filled with other substances different from *Magneticall* nature, and many mountaines *Magneticall* mounted aboue these substances higher and lower, so that some attract, being aboue the point of the *Inclinary-needle*, some being vnder it; some placed before it, draw the point of the *Inclinary-needle* vp vnto them, other behind it, beeing also adamantine forts will haue this *Inclinary-needle* strike faile to them also, by which meanes the naturall conformity of the *Inclinary-needle* to his naturall angles is much disturbed and depraued, whereby it commeth to passe that this needle hath his variation also, as well as the directory-needle hath, as is before demonstrated.

Therefore the variation of the *Inclinary-needle* is,  
when

when in one altitude of the pole this needle pointeth out another angle, different from the true and respondent angle of that latitude of the pole, being hindred by a mountaine, or part *Magneticall*, that doth attract one of the points of the *Inclinatorie-needle*, approaching neerer vnto it, either neerer the poles or æquator, in so much that the angle of inclination is made lesse or more then it naturally would be.

In sailing East or West vpon a paralell, hauing his land on the side towards the pole, consisting of *Magneticall* substance, this will attract the *Inclinatorie-needle*, and cause his naturall position to be more perpendicular then it would be.

If the shore about the pole be situated betweene the *Inclinatorie-needle* and the æquator, this adamantine eminency will attract the needle vnto it, making his inclination lesse plumb then naturally it is.

In sailing East or West neerer the æquinoctiall, where the carriage of the *Inclinatorie-needle* is lesse perpendicular, and more tending to the leuell with the horizon, the *Magneticall* eminency betweene the pole and the needle, will pull downe the higher end of the same, and make him more paralell to the *axis* of the earth, then naturally he could endure.

Euen so an adamantine mountaine, betweene the *Inclinatorie-needle* and the æquinoctiall line, will lift vp the lower end of this needle, being within the *Magneticall* vigor of that mountaine, and make him more paralell with the horizon then his naturall conformity requireth in that paralell.

The variation of the *Inclinatorie-needle* is greater in the parts neerer the æquinoctiall, then it is in the parts neerer the poles, where this needle is not attra-

cted so many degrees from his naturall angle, as vsually he is neere the æquinoctiall.

If in the parts neere the poles, the *Inclinary-needle* be caried betweene two eminences *Magneticall*, in that space of the straight where both their vigors be of like validity, they will make the application of this needle perpendicular, crossing them both at all right angles, not much vnlike, as it is in XV. Chapter of applications, *Table VIII. Fig. 1.*

In sailing neerer the æquinoctiall in straights betweene two adamantine mountaines, whose vigour attractive surpasse the generall vertue disponent of the *Magneticall* globe of the earth, these will lay the *Inclinary-needle* in a paralell and leuell to the horizon, though they be many degrees from the æquinoctiall, as Chapter XV. *Tab VIII. Fig. 2.*

Lastly, in passing or sailing neere and ouer a vigorous *Magneticall* rocke, in the sea, or earth, vnder vs, in approaching neerer vnto it, the same will attract the *Inclinary-needle* from his right place, and comming neerer the rocke, it will alter him much more, and passing ouer the same, it will attract the needle perpendicularly, and being past, this needle will be freed by little and little from that disturbance of his naturall inclination.

These varieties are found vpon the *Magneticall* globe or *Terrella*, by hauing a conuenient peece, or peeces of iron placed thereon, as hath bene sayd, and placing the *Inclinary-needles*, before described in the II. chapter, the one of them put vpon a Lute-string, the other in his frame, *Tab. II. Fig. 17. 18. or 19.* so that I hope I need not set downe any types hereof, for the ingenious will better conceiue how to gather this matter



matter from the globe of the *Loadstone*, then I can possibly explaine in many troublesome figures, or the workeman deliniat by his skill vnto you in printed tables and figures.

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CHAP. XXXXII.

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*Of finding the variation of the Inclina-  
tory-needle.*

**H**Auing declared the manifold causes of the variation of the *Inclinary-needle* from his true and naturall angle of inclination with the horizon; it followeth that we deliuer plainly how to discern these euents when they shall fall out, which are known perfectly by hauing the true eleuation of the pole, where these matters shall be required.

The rules and wayes how to know the eleuation of the pole in all places, is so perfectly set out by most Astronomers and writers of Nauigation, and so well knowne to all expert Pilots, that it is a thing needlesse here to repeate them.

Besides the ingenious Pilot knowing the eleuation of the pole in some places of his voyage that he hath passed, by keeping a true, not a dead reckoning of his course in pricking his Card aright, and obseruing the way with the logge-line, with other currants and occurrants, will giue a very artificiall coniecture of the eleuation of the pole in that place where he is, though he see neither Sunne nor Starres.

Notwithstanding because the skilfull Pilots may be hindred in this kind of obseruation, by the falling of the ship to Lee-wards, and by other extraordinary change of weather, and other disturbances that may many wayes fall out at sea, therefore I will onely remember one way out of the principals before deliuered, whereby he may at any time of the day, the Sunne shining, know the altitude of the pole.

This thing is chiefly performed by knowing the true variation of the Compasse, which sheweth the true meridian for that place, presently seeke out the true Azimuth also, which is perfectly knowne by the shadow of the Sunne vpon the limbe of the Compasse, by the furniture of the beame, before described, instantly take the altitude of the Sunne by the *Jacobs* staffe at sea, or a large quadrant at land.

The true Azimuth and Almicanter thus knowne, seeke the point where they crosse the one the other in the Rete of the *Mathematicall Iewell* and *Astrolabium Catholicum*, then obseruing the paralell of the Sunnes declination for that day, turne about the Rete of this instrument, vntill this paralell of the Sunnes declination be touched by the point, where these two circles of altitude and position meete, and then the horizon of the Rete will shew in the limbe the latitude of that place.

The latitude of the pole for any place being knowne, the true angle of the *Inclinary-needle* is manifest and apparant, as it is set downe and knowne by the XIII. chapter, in the chapter to know the angles of inclination by the instrument, and in the table of the degrees of the *Inclinary-needle*, answerable to euery eleuation of the pole.

Now

Now obserue the degrees that the *Inclinatory-needle* pointeth out in his ring in that place, and take the difference of these from the degrees of the true angle, and that is the variation of the *Inclinatory-needle* for that place.

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CHAP. XXXXIII.

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*Of finding the Longitude.*



Ere I purposed to haue ended this short Treatise of *Magneticall* matters, but because that this thing is not altogether impertinent thereunto, I thought it not superfluous to annex this little chapter of finding the longitude, for although that the *Magneticall* needles, before treated of, do not shew the longitude; yet because the true meridian and altitude of the pole is knowne by them, there is much helpe brought thereby for the knowledge of the longitude, which by a few easie obseruations more, from the body of the Moone, will be obtained, whose motion if it should be set downe and ordered in an exact manner, would require a large discourse, with many rules and obseruations of the Moones inequality of motion, anomaly and prosthapherisis, of his excentricity, paralaxis, with the varietie of his latitude and nodes, which thing, being very laborious and curious, shall be here omitted, referring you herein to *Tycho Brahe* and his rules, and onely I shall here set downe rules to know the place of the Moone at a larger scantling, yet very neere the truth



(though not the truth it selfe, which peradventure the best Studied in this kind can very hardly do) only borrowing halfe a dayes motion at the Moone, wherein the matters before mentioned will not alter many minutes.

Provide an Almanake or Ephemerides for any place or port, wherein the apparent place of the Moone in the Zodiacke is exactly set downe in degrees and minutes for the noone of euery day, especially of the day of obseruing, then take the difference of the Moones motion from the day before, and reduce it into minutes, deuiding them by 24 houres, the quotient will shew what minutes the Moone moueth in an houre.

Now take the altitude of the Moone at any time of the day or night by the *Jacobs* staffe, or a quadrant, then obserue the Azimuth of the Moone by shadow, (as before for the Sunne) or by a ruler with sights, which if it do differ any howers from the meridian, allow the parts due of the Moones motion.

Then seeke in the Rete of the *Mathematicall Iewell*, or *Vniuersall Astrolabe*, where the Azimuth and Almucantaraph of the Moone, newly obserued, cut each other, setting the horizon to the altitude of the pole, and looke what paralell doth cut these two, and follow the same vnto the Eclipticke line (or do the like of the Moones latitude) in that signe, degree, and minute of the Zodiacke, the Moone is in at that instant.

These degrees, fewer or more then those of the radical and fixt meridian, for which the Ephemerides was made, do shew what howres and parts are to be added, if the obseruation be towards the West, or subtracted if in the East, to this meridian (it is to be noted that euery hower containeth 15 degrees of the Equinoctiall)

and



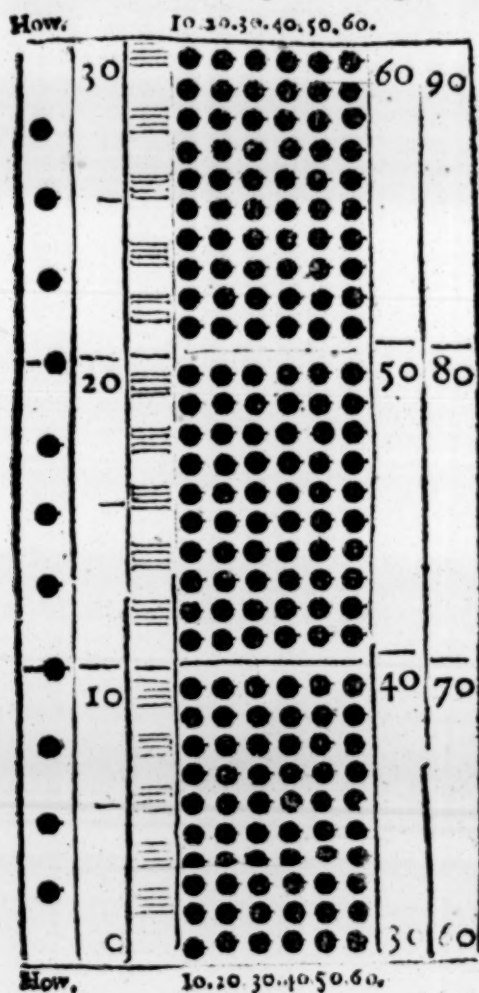
and thus the longitude of that place you are in, will be attained, which you desire.

But to find the longitude of any place you go to, from the place you passe from, by these *Magneticall-needles* onely, it will be necessary to pricke your Card as well by the degrees of latitude of the pole, correspondent to the angles of the *Inclinary-needle*, as by the way the ship maketh vpon the points of the *Director-compassse*, and therefore it will be fit to haue both these needles placed together, as in the type of the XL. Chapter, and pendant before the Mariner at the helme with the Compassse and Trauers-boords for them both.

Now for this purpose I would haue another Trauers ruler or limbe for the quadrant of the *Inclinary-ring*, placed before him, as it is described in the Page following, where there is only 30 degrees deuided vpon the same, which being twice more repeated, will make vp 90 degrees, euery degree hath 6 holes, for pegs to be put into them, for the number of 10 minutes apeece, and on the first columnne on the left hand there are 4 holes made to receiue pegges according to the number of howers you saile on such a degree and minute, pointed in the *Inclinary-ring*.

Besides these instruments, prouide a perfect Sea-card for your voiage, with the lines of the winds, & the lines of the longitude & latitude placed therein; then obseruing the way that the ship maketh in an hower, by the log-line prick your way on the card out of the Trauers-boord for the point of the Compassse you saile on, also by this second worke pricke your Card by the same way with the degree of latitude you finde by the degree of the *Inclinary-angle* in the Trauers-limbe, as it

is



is correspondent by the wayes, instruments, and precepts deliuered from the *Inclinary-needle*, then obserue in the meeting of these two sorts of pricking, what meridian passeth by them in your Card, and that sheweth the longitude of the place where you are, from that from whence you came; and thus your Card is pricked both for longitude and latitude only by these *Magneticall* needles, when you can see neither Moone nor Starres.

If any errors should chance to fall out by any variations


tions of either needle, then at any time when the Sun doth shine they may be amended by the precepts already largely deliuered in that case of either, both in many Chapters of this booke, and in the last precedent Chapter.

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CHAP. XXXXIIII.

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*Of the matter of the Magneticall globe  
of the earth by the Needle.*

T length we haue brought our short Treatise *Magneticall* principally & most profitably to declare the nature of the *Directory* and *Inclinary-needle*, both towards the *Terrella* and *Semiterrella*, and towards the *Magneticall* globe of the earth, and how the proportions and similitude of their applications and conformities to both are alike and the same.

Onely the *Magneticall-needle* being of a fæminine and sequent substance, as hath bene demonstrated in the VIII. XXI. and XXII. Chapters, doth behold the round *Magnet*, and the round Iron, with that point that is of the same nature and demonstration that the pole is, which he followeth and affecteth, contrary to the nature *Magneticall*, that is in the Adamants themselves, one towards the other, or of the needles one towards the other.

But this *Magneticall-needle* being freed from the *Magneticall* orbe of the *Loadstone* and Iron, will haue that point of the needle that followed them directed

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by the vertue *Magneticall* of the earth into a contrary prouince of polar preheminence.

For the *Magneticall-needle* doth conforme it selfe vnto the Earth in the same fashion that the Adamant and *Loadstone* it selfe doth; neither is it so seruiceable vnto the *Magneticall* globe of the earth as he is vnto the *Magnet* and Iron, but is of a fellow-like species with the earth, as well as the Adamants themselues are.

Whereby I do gather that the matter of the interior parts of the *Magneticall* globe of the earth is not the same with these we know of the *Loadstone* and iron, into whose bowels neuer any mā, by the deepest mines, or other passages of fissurs and cauities, made by great Earth-quakes, euer yet descended to shew vnto vs any part of the earths interior substance *Magneticall*, and though I take the matter of the bowels of the earth to be *Magnetical*, yet the application of this *Magneticall-needle* demonstrateth, that the *Magnetical* globe of the earths inward substance consisteth neither of sollid *Loadstone*, nor of iron-like mine or clay or such like materials, as they which haue thought themselues most skillfull in *Magneticall* Philosophy haue imagined.

For if the *Magneticall* globe of the earth were of any Iron-like substance, then that point of the needle that affecteth a polar iurisdiction, placed neere the *Loadstone* and the iron, would also, being applied vnto the earth, behold the same prouince and iurisdiction polar, being directed by the vigor of the earths *Magneticall* orbe of like nature; but this is not so, as all confesse and may proue.

Therefore I hold that the great *Magnetical* globe of the earth consisteth of a *Magneticall* substance vnknowne vnto vs, as also the bodies of the *Magneticall* globe  
of



of the Moone and of the rest do; and so conclude that the workes of God are most wonderfull, and altogether past finding out.

But here before I end, I am to satisfie that I made promise of in the XII. Chapter, that I would shew my conceipt of the reason why the needle in his passage from the æquator of the *Magnet* by the pole, to the æquator againe, should make the circumuolution of an whole circle in turning about his foote, hauing passed a semicircle of the *Terrella* or *Semiterrella*, and would make another whole circle about the other semicircle of contrary nature with his other point.

For to cleere this with the nature of the two provinces, which is aduerse one vnto the other. I would wish that you would conceiue and propound two globes of *Magneticall* nature and substance, as tender as clay, the one of them to be animated with the North and articke vertue at both poles, as *Tab. XX. Fig. 3. aa*, to turne to the North onely: and the other globe, with his poles *Tab. XX. Fig. 3. bb* to be endowed with the antarticke power to moue to the South onely.

Now if this globe of the earth, or of the *Magnet-stone* were made onely of one of these globes, then there would be a strife betweene the poles of one of the globes, which should behold his peculiar point, as if the pole *a* of the North vertue should behold the North; the other pole *a* of the same globe, being of articke nature, would also strue to behold the North, or at least in their equality of power would rather respect East and West, so that there would be no stability by the poles of such kind of globes.

Therefore the skilfull Potter, who made the earth

and all *Magneticall* bodies at the creation, and gave life and vigor to all things, thought fit to provide two *Magneticall* globes, the one of poles and circumference of North and articke nature, *Tab. XX. a a*, and another globe of South and antarticke vigour, *Tab. XX. Fig. 3. b b*, that these vnited together, the one might keepe the other in steady position, yet because that these globes touching the one the other but in a point at *a* and *b*, *Tab. XX. Fig. 3.* could not keepe any firme steadfastnesse, therefore this skilfull Potter vsed the Art of Geometrie to put these two *Magneticall* globes, with all their efficacie, into one globe, as *Plato* doubled the Cube, and whereas the slope line *b c*, *Tab. XX. Fig. 3.* in the figure is double to the side-line *c e*, *Tab. XX. Fig. 3.* therefore he extended these two models of these two globes, like clay, extinguishing the poles that touched at *a* and *b*, *Tab. XX. Fig. 3.* and expanded the same vnto the æquator of a doubled globe, that contained within his diameter both these globes of articke and antarticke nature, the one of them on the North-side of the æquator, and the other on the South-side of this large extent, with the efficacy of their materials *Magneticall* and circumference, wholly bending to their proper prouince and poles, and because the efficacy of one of these prouinces from the æquator, is the effect and power of an whole globe of one simple nature *Magneticall*, therefore the *Magneticall-needle* passing this semicircle or hemisphere, doth describe a whole circle, with the distinction of his parts and quadrants by the point, that is of the same nature; as also passing about the other hemisphere, the other point of the needle being of the nature of this side, doth trace another whole circle about

bout his foot; so that here is two whole circles pricked out by the Needle in passing about the Earth, or the rounded Load-stone; And thus haue we briefly and plainly tricked out that which we had to

say of *Magneticall Bodies and Motions.*

The severall formes or fashions of all the Magneticall stones described in this Booke, you may haue most exactly cut and truly capped to all advantage, by Nicholas Tixouer, whose experience and true understanding in this faculty is approved and well knowne vnto most of the skillfull Mathematicians about London. You may enquire for him in Sheere-lane within Temple-barre, at the house of Roger Bouse Black-smith, or at the Printers house of this worke.

*Faults escaped in the Printing.*

In the Table. ch. 13. for no circle, r. one circle. Tab. ch. 29. for of the r. by the. P. Ag. 1. line 31. for trauersers, read trauerfers. p. 6. l. 3. for two teeth, read with two teeth. p. 10. l. 31. for sithe, r. stithie. p. 14. l. 22. for twelue r. fourteene. p. 14. l. 29. for sixty r. one hundreth and forty. p. 20. l. 3. for lenities r. cauities. p. 25. l. 8. for turne, r. turne South. p. *ibid.* 14. point r. point North. p. 32. l. 4. for Magnet from, r. Magnet being remoued from. p. *ibid.* 1. 9. for will, r. he will. p. 33. l. 24. for Directory-needle, r. Inclinary-needle. p. 35. l. 28. for that inclinatory maketh, r. that the Inclinary-needle maketh. p. 45. l. 31. for seeth r. seateth. p. 68. l. 27. put out, now the sides be turned, & these are also turned. p. 70. l. 30. for excited r. exciting. p. 77. l. 30. adde Ta. XI. fi. 4. p. 83. l. 4. for fashioned r. fastned. p. 90. l. 17. for which are bare, r. which bare. p. 90. l. 17. for armor to take, r. armor take. p. 90. l. 31. for Magneticall bodies, parts, r. Magnetic all bodies, and of their parts. p. 91. l. 9. for vnnaturall, r. naturall. p. 92. l. 27. for boule r. bole. p. 102. l. 18. for demonstrated, r. demonstrable. p. *ibid.* l. 24. for passing, r. passed. p. 113. l. 9. for of the center, r. at the center. p. *ibi.* l. 25. for vpon the signe, r. vpon this whole signe. p. 119. l. 24. for called, r. added. p. 120. l. 22. for be, r. will be. p. 129. l. 24. for FG is 18, 15. r. FGA is 50. p. 131. l. 10. for 67|78|25| r. 67|78|22|. p. 135. l. 33. for making at the same, r. making right angles at the same. p. *ibid.* l. 3. for to E to, r. to E 10, p. 151. l. 21. for 4 holes, r. 11. holes. p. 153. l. 26. for demonstration r. denomination.

FINIS.





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LONDON,  
Printed by Nicholas Okes, dwelling  
neere Holborne-bridge, at the  
signe of the Hand. 1613.

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